THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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PUSHING THE SALE OF ELECTRICITY IN LONDON.

In view of the decision of the Associated Municipal Electrical Engineers of London (which was reported in our pages early in December) to form an Electric Supply Publicity Committee for London and district, in which both municipal and company undertakings will join hands for their common good, it is opportune to look into the possibilities of this purely commercial alliance rather closely.

It is well to recognise at once that this is only the first step towards a solution of the problem which confronts London's electricity suppliers, and while it is a very welcome move—in view of its recognition of the necessity for combination—though somewhat late in the day, it inevitably raises speculations as to the possibility of future concerted action on the same lines.

To put the case briefly, we have in the Administrative County 16 municipal and 13 company undertakings, while there are over 40 similar supply undertakings either adjoining or in close proximity to the metropolis, the bulk of them independent concerns and non-competitive as regards each other, working on purely local lines, and not more than one or two of them possessing any real organisation for the development of business—let alone meeting strenuous competition.

It seems strange that such haphazard methods of doing business should exist, or, at any rate, should have been tolerated for so long, more especially in view of the keenness and excellent organisation of the two large gas companies which are solely responsible for the competition in the greater part of the area offering the richest commercial possibilities.

We can only conclude that the rooted antagonism between municipal and private enterprise has been the great deterrent to a common-sense attitude on the part of the London suppliers in the past, notwithstanding that thereby the earning power of some 20 millions of capital was seriously impaired.

The problem which faces the London suppliers is the purely commercial one of methodically promoting the sale of electricity, and its efficient utilisation, over the whole of the so-called London area, irrespective of supply, supplier, or artificial boundary, but of necessity with due consideration to the needs of the districts involved. Certainly it appears to us that it is only by handling the London area as a whole, adopting a consistent policy throughout, and organising the business on well-thought-out lines, that the highest degree of commercial efficiency can be attained.

Looked at from this standpoint, there is an obvious necessity for a central organisation, representative of the various supply authorities—not merely a publicity committee such as that already formed—but one which shall have entire control of the preliminary business-getting, through the intermediary of a fully qualified, and therefore substantially

remunerated, manager; and a staff of district managers who would make the local showrooms their headquarters, would supervise local canvassers and publicity operations, ensure the linking-up of supplier, contractor and would-be consumer, and generally direct matters so that there would be no possibility of the continuance of the present state of things, where, even with recognised canvassers, thousands of possible users are neither written to nor circularised, while with the existing very limited commercial staffs they certainly cannot be called upon.

This brings us back to the publicity proposal, which must be recognised as only a step—in fact, the first step—in the right direction. In no case can this measure be effective unless directed in each locality by someone having first-hand knowledge regarding that district and the probable needs of its residents and possible consumers.

The second step, of following up literature by a personal call, seems to us to be in very many cases indispensable to the success of the first step, for it would naturally bring in its train inquiries and requests for information which could be satisfactorily met by demonstration of apparatus at a local showroom.

Judging by the trifling cost of the initial move (approximately 2s. per £100 of revenue), we do not suppose that objection would be taken to a more extensive propaganda merely on the score of cost; objectors there are, no doubt, to any attempt at commercialising electric supply, but they are few and far between, and surely even they would favourably consider a proposal which would give them all the advantages of their more energetic neighbours in exchange for a comparatively small monetary contribution.

Clearly the situation calls for a complete "business-getting" scheme which shall include the lesser and pure "publicity" scheme. The latter by itself, or even if followed up in the present desultory fashion, may be robbed of half its value, for it is inconceivable that anything but a completely organised effort can possibly meet the competition of the two leading London gas companies, with their 30 millions sterling of invested capital and 900,000 consumers, not to mention that of the dozen or so smaller concerns.

There never has been any lack of keenness or method in the competition of the large gas companies, who, if they have suffered from the inroads of electricity in certain well-looked-after districts, have had things all their own way in the far more numerous districts where only the feeblest attempt at competitive electricity supply existed. It is largely due to this inexcusable neglect of opportunities by electricity suppliers, that so many builders instinctively run gas piping in their houses and thereby initially handicap the electricity supplier, in spite of his having such a serviceable help as the new metal-filament lamp is admitted to be.

Half measures are never satisfactory, quarter measures are generally all but useless, and for this reason we urge the London electrical authorities to go the whole hog, launch a complete scheme without delay—and reap the full reward.

Letting in the Gas-Man.

We are not deterred from uttering a friendly warning to the Dublin Corporation by the fact that certain remarks which we felt called upon to make upon their electricity department's business were not received with any show of gratitude from that quarter.

The *Irish Times* of January 1st contained a paragraph ominously headed "Proposed Increase in Electricity Rates," which set forth that the Lighting Committee would recommend the Corporation to increase the rate for lighting purposes by 10 per cent., upon the ground that the consumers had been saved £15,000 in 1909 by using the metal-filament lamp.

This was the second time within a year that the Lighting Committee had made this recommendation, and, without knowing anything more of its report than was to be gathered from the short preliminary notice in the *Irish Times*, we say unhesitatingly the Corporation ought to have rejected the recommendation again if it did not wish to wound grievously its already sick electric lighting business.

As a matter of fact, the Committee was in a terrible fix, for the city treasurer had sent it an ultimatum drawing attention to the bank overdraft of £43,000 on electric lighting account, and refusing to permit the Committee any longer to avail itself of credit balances on other Corporation accounts as a means of carrying on the undertaking, unless there was a re-adjustment of the lighting charges, which, in his opinion, should be increased by at least ½d. per unit.

An increase of 10 per cent. at any time would check progress as much as a financial crisis in Dublin City; but just at this time the gas company is reducing its rates, and the effect of an increase in the cost of electricity will be disastrous.

We regret to say, however, that the Corporation has given way, and has backed the wrong horse; for, by a large majority, it has decided to put up the lighting rates by ½d.

We hope that the increased smell, which, we understand, the gas company are giving for the reduced price, will counterbalance to some extent the self-wounding ordinance of the Corporation.

Copper.

The copper market still appears to be affected by the rumoured American consolidation, the more so, probably, because information on the subject remains indefinite. The "billion-dollar" stage of the rumour has passed, and the estimated capital issue likely to be adopted by the combination is quoted from the New York *Mining and Engineering Journal* as more likely to be 150 million dollars. The combination proposed is to include the Utah Copper Co., the Nevada Consolidated, Nevada Northern and Cumberland-Ely with the Boston Consolidated, later acquiring the Garfield "smeltery" and Baltimore refinery of the American Smelting Securities Co.

As the above companies (with the exception of the recently-acquired Boston Consolidated) have hitherto been under Guggenheim control, the writer giving the above particulars surmises that the combination of these companies is to be effected with a view to absorbing other interests when the matter has reached a working basis. The *Financial News*, announcing the signing of the contract by which the Boston Consolidated Copper Co. was taken over, gives practically the same companies for the combination as in its article quoting from the New York journal, and adds that they represent about 55 per cent. of the production of the United States. It points out that supplies have accumulated in the States, and that European supplies are unusually high, and therefore the maintained price of copper augurs confidence in the success of the combination, concluding with the shrewd observation that the independent copper companies stand to gain.

In an earlier article, the *Financial Times* writer was inclined to consider the prospect of the Phelps Dodge interests (output about 80,000 tons) and the Calumet and Hecla mines (output 30,000 to 40,000 tons) holding off from the combination. It is probable, of course, that the independent companies are fully aware of their position, and make what terms they can. The combination thus appears to be held between the two disadvantages of early arrangement and a consequent rise in prices, and abandonment of the more expensive companies, thus leaving awkward rivals in the field. Heavy sales of standard were recently announced, though the effect on the price is not expected till towards the end of this month. Combined with a large bull account, the maintenance of the price in the neighbourhood of £60 does not seem due to natural causes.

In spite of the limitation of the combination, prices continue to harden in a most optimistic manner. The *Financier* publishes an article (January 3rd) taking the view that this is not merely temporary. The writer ascribes the prices reached a short time back to the "anxiety of actual producers to secure the metal at what they thought were likely to be bottom prices, or thereabouts. When this sentiment had made itself felt, American producers took advantage of the fact to unload very large quantities of copper at the better figures, and the thing was a little overdone. A slight relapse was inevitable, but there has been a recovery, and the recovery is something more than a market fluctuation." The article further refers to an understanding between leading producers that the output is to be limited by 10 per cent., and to the general anticipation of a trade revival extending to England, as well as to the United States. At the same time, it is considered certain that mining development, including that of the important Butte Coalition Co., will enable any heavy demand to be dealt with. The Cerro de Pasco Co. (Peru) is also mentioned as producing 25,000 to 30,000 tons per annum.

In support of the higher price view, the *Mining World* refers to the calculations of Dr. James Lawford, who traces a relationship between the production of iron and that of copper. This statistician finds that for the past nine years the average world's production of pig iron and pig copper has been 76 tons of iron to one of copper. In 1908 it was only 63 tons to one of copper. But during the third quarter of the present year (1909) he finds that the iron output has run away from the former proportion to copper, and argues from this that the world will presently be demanding its arrears of copper to make up the average. The value of such statistics can only be realised by estimating to what extent the high consumption of copper in 1908 was due to electrical activity in the States and elsewhere, and how far the increased iron production is attributable to the development of certain trades, such as structural steelwork for building, re-inforced concrete, &c.

Everything points to an increasing demand, but supplies are at present so satisfactory that it seems early to anticipate a rapid rise in prices. The visible supplies for the end of December, as given by Messrs. H. R. Merton, total at 109,022 tons, re-shipments to America being only 25 tons. American supplies are down, as would be expected with such large home stocks, Spanish above average, Chilean up to average, Australian low. The visible supplies are largely made up of standard at English ports (94,849 tons), and afloat from Australia and Chile, 7,050 tons.

Platinum.

The advantages of combination, since the Steel Trust, seem to appeal in turn to those interested in other metals. Platinum is under discussion for an organisation of this kind, the promoters being a French syndicate. Largely interested is an important British firm, which holds a contract for the entire output of several mines for some years ahead. As pointed out by a writer in the *Financial Times*, from which the above is quoted, Russia is the only considerable source of supply, and the organisation of the industry appears to be lacking in many respects. The mine-owners are much hampered for want of capital, and extensive smuggling prevails. In 1891 the output (according to official statistics, to which probably 100,000 oz. should be added) was 136,000 oz., in 1894 it rose to 167,000 oz., and in 1898 to 193,000 oz., reaching in 1901 203,000 oz. Since then the output has fallen off, amounting in 1908 to 156,000 oz., but tending to increase. Of this output about 100,000 oz. per annum is consumed by the United States, Germany takes 100,000 oz., Britain about 25,000 oz. and Russia perhaps 3,000. The only other sources of supply are Colombia, with an output of 9,000 oz., and the United States, Borneo and New South Wales, with about 500 oz. each. It is evident that, in a small industry such as this, it is quite competent to a few capitalists to corner the entire output, but any inordinate elevation of the price would largely stimulate the use of substitutes, where possible, and the discovery or development of fresh sources of supply. Much may, however, be effected by aiding and encouraging the producers to place the business on a more paying footing.

The Furness Co-Partnery System.

In our issue of December 24th last we commented on a letter issued by the secretary of Irvine's Shipbuilding and Dry Docks Co. to the employé shareholders, reminding them that the 12 months' trial of the co-partnership arrangement formulated by the chairman of the company, Sir Christopher Furness, was drawing to a close, and asking the men to decide as soon as possible whether or not they proposed to continue working on the same basis.

The letter explained that the period during which the co-partnership had existed had been one of the most successful in the company's history. There had been an entire absence of strikes or disputes, which was one of the conditions of the agreements, with the result that contracts had all been completed to time, and some even in advance of the contract date for delivery. Not the least satisfactory result was that the shareholders would receive a dividend at the rate of 10 per cent. on their capital, whilst the workmen shareholders or co-partners would receive their guaranteed 4 per cent. interest, plus a 5 per cent. dividend, or a return of 9 per cent. on the amount of their holding.

It is important to note that, even if the men had received no dividend at all, their average wages must be considerably more than in former years, when the frequently recurring strikes and stoppages so largely reduced the working hours.

Following upon the secretary's letter mentioned above, a mass meeting of the employés was held on December 29th, in response to a requisition signed by the whole of the members of the Works Council, in order to hear an address by Sir Christopher Furness on the results of the year's work.

Sir Christopher, in the course of his address, expressed his profound pleasure at the manner in which the employés had responded to his proposals. The Works Council had speedily got to the true basis of co-partnery, the basis of genuine comradeship, and the men had worthily upheld, at a time when people were inclined to be sceptical, the reputation which their various British qualities won for their country half-a-century or more ago. His earnest hope had been to harmonise the association of capital, labour and enterprise; and the results had more than justified such hope. When they recalled the almost daily incidents of strife and delay due to discord and lack of harmony, it must be conceded that few principles had enjoyed so great a justification in so short a time. Punctuality, assiduity, economy, ingenuity, interest in their tasks, were certainly not common, although they might perhaps be described as common-place virtues. It was with sincere pleasure, therefore, that he had gained the impression that under the new *régime* these virtues had been much more in evidence than had been customary in late years. To stand sixth in the United Kingdom in shipbuilding production, and to be credited for 1909 with a greater tonnage even than Harland & Wolff, was no mean achievement.

Judged by the financial success of the co-partnery scheme there is every reason to be satisfied, but a mere money return was not the be-all and end-all of co-partnery; indeed, the speaker was tempted sometimes to regard this as the least important result. By their mutual renunciation of the right to strike and lockout, accompanied by the condition of a scheme of arbitration, they had adopted a system which in all human probability would serve the purposes of justice far more quickly and effectively than any strike or lockout would do. It was impossible, however, even in a co-partnership system to guarantee a condition of permanent employment and prosperity, and he was their worst friend who would talk undiluted optimism to them. But if co-partnery could not secure permanent employment, no other system in the civilised world could do so.

Sir Christopher then asked the men if they were prepared to continue the co-partnery practice or to revert to the simple wage system; to abandon the paths of peace for the system

under which they were harrassed constantly by bitter controversies, living always in an atmosphere of care, worry, and fear. He hoped they would cast their vote for the system which, in addition to a probability of a better return in coin of the realm, gave a condition of greater peace of mind, and helped to a refreshing concern in their daily toil, and conferred on them the distinction and dignity of absolute manhood.

The address concluded with the following peroration :—"Granted the possession of the reason, the faith, the devotion of my employés; assured of their loyalty, their zeal and their goodwill; the subject of their warm and firm friendship; there is no position however eminent, no title, however flattering, no measure of enrichment, however generous, which I would exchange for the distinction attaching to the chairmanship of the company which is playing a part so original and so important in proclaiming the innate power of co-partnership to cure the industrial ills of England, and consequently to strengthen and to invigorate her for the grand combat lying right in front of her—the momentous combat with those giants of intellect, ability, and enterprise, Germany and the United States. Let co-partnery flourish! For if co-partnery flourishes Britain may bear herself bravely and quail not."

Lord Rothschild and the Electrical Industry.

In electrical circles of late complaints have been made that the lack of enterprise or sympathetic support by English financiers is largely responsible for the absence of prosperity in the industry. Even the financier is but human, and, in the person of the typical representative of finance, he has turned. Lord Rothschild has been speaking about the electrical industry. In the absence of a more complete report of his speech, we are dependent on a summary thereof in the *Daily Mail*, and our quotation must be understood as being what the *Daily Mail* says that his lordship said :—

Lord Rothschild, at Wolverton.—The action of Mr. Lloyd George in refusing tramway and lighting concessions to private companies is ruining such firms as Messrs Thomas Houston and Messrs. Dick, Kerr, who lost the contract for the Victoria Falls power work to Germany because they dare not put down plant great enough to cope with such an undertaking.

The inevitable result of the elevation of an individual into a popular idol, on the one hand, is to promote a tendency to regard the same individual as the source of all evil on the other hand. It is one of the methods of compensation which is utilised mechanically to avoid error, though it must ever be a source of wonder to the engineering mind why politically such extremes are necessary before the real mean is reached. Lord Rothschild does not attempt any defence of the financier from the charges which have quite recently appeared in the electrical Press, but he utilises the circumstances for an attack on the Chancellor of the Exchequer. We are not concerned with any defence of the popular idol or source of all evil, as the case may be, but we are concerned that no inaccurate views should circulate regarding the electrical industry, and we are therefore interested enough to ask what has Mr. Lloyd George done to refuse lighting and tramway concessions to private companies? Was it not during his period of office in the now dissolved Government that the round-table conference between electricity supply authorities was proposed and favoured, and while he was at Westminster that the London companies were authorised to link up for mutual assistance, and were relieved of a possible rival, improving their prospects altogether, after a trying period; was it not only a few months ago that the Electric Lighting Acts (Amendment) Act was passed? But go back 20 or 30 years, and what do we find?—the short-sighted action of Mr. Joseph Chamberlain in the Electric Lighting Acts of 1882 saddled the electrical industry of this country with burdens which have been blamed by electrical financiers a hundred times in Press articles, and in company and other speeches. "Mr. Lloyd George is ruining Dick, Kerr & Co."; what do Dick, Kerr and Co. say to this?—6 per cent. last year on their ordinary capital! And for a number of years before that never less than 10 per cent. per annum, and sometimes a good deal more. "Mr. Lloyd George is ruining Messrs. Thomas (*sic*) Houston"—where is the proof? "Dick, Kerr and Co. lost the contract for the Victoria Falls power work to Germany." And so did every other British manufacturer, too, for the matter of that. But was it because Dick, Kerr and Co. or the Rugby company could not cope with so big an undertaking? Of course it was nothing of the kind. The contract was never offered to British firms on the same terms as were granted to the German interests. That is one reason. The other is alleged to be due to financial interests.

Lord Rothschild has followed some others in seeking a simple solution of a complex problem, and necessarily with the same lack of success. But for the fact that, as the *Times* truly says, "the heat of an electioneering campaign is more favourable to loose talking than to clear thinking," it is probable that his lordship would have realised that the subject he was dealing with had some relation to demonstrable facts, and would consequently have taken some trouble to ascertain them correctly. If electrical interests must be dragged into political discussions, the facts should be correctly stated, whatever inferences be subsequently drawn from them.

If this excerpt from Lord Rothschild's speech is incorrect, then the *Daily Mail* must bear the responsibility of publishing such utterly frigid and calculated terminological inexactitudes.

Electrical Exports in December.

The improvement in trade continues. The official returns just issued are more encouraging than any that have appeared for some time past. For the month of December there are advances of 6·9 per cent. in imports, 14·9 per cent. in exports, and 17·6 per cent. in re-exports. The returns for the complete 12 months show advances of £31,787,030 (or 5·3 per cent.) in imports, of £1,275,620 (or 0·3 per cent.) in exports, and of £11,741,768 (or 14·7 per cent.) in re-exports. In manufactured iron and steel goods, and metal manufactures, exported, there were big advances, and electrical goods and apparatus were better by the substantial sum of £135,009, as compared with the corresponding month of 1908. Telegraph cables and apparatus account very largely for the improvement in electrical exports, and electrical machinery in considerable quantities was despatched to India, China and Argentina. Let us hope that such exports will continue to increase in volume and value for many months and years to come.

Notes from India.—One of our Indian correspondents writes as follows:—

"*Rangoon.*—This up-to-date and flourishing capital city of British Burmah can boast of a very modern system of both electric tramways and electric lighting and power supply. It took years of thought and columns of advertising before the municipal authorities could make up their minds as to what system to adopt. Finally, they determined on three-phase alternating current, transformed to D.C. for trams, and stepped down to 460 volts for large motors, and to 230 and 115 volts for fans and lighting.

"Electrical business generally is active; new buildings are being rapidly erected, and demands for electric wiring, fittings and fans are considerable.

"Electric lifts for high buildings are becoming a necessity rather than a luxury, and it is not uncommon to see lights and fans in the smaller Burmese and Chinese bazaar shops. Many attempts have been made by enterprising contractors to introduce an entirely satisfactory alternating-current fan, but it cannot be said with certainty that such has yet been done. There is a paying market in this particular item alone, and it is hardly credible, but it is fairly true, that no English-made A.C. fan, with perhaps one exception, has been put on the market at all. Italy and America are vieing with each other for success; *palmam qui meruit ferat*. The British-made A.C. motor for larger work is holding its own fairly well, which is something to be thankful for.

"*Cooking and Heating Apparatus.*—The amount of business done in this line in India is very small indeed. It is noticeable that since the advent of the metal lamp at home serious endeavours are being made to push business in these commodities so as to induce a day load, or even to maintain an average load. It is to be hoped that these endeavours will cause special attention to be paid by manufacturers to the necessity of improving the design of cooking and heating apparatus. As at present exported, most of them are flimsy to a degree, liable to get out of order even with average handling, and it is a matter of extreme difficulty to execute repairs without sending the damaged article home. Given a well-made, reliable, sturdy heating or cooking article, difficult to damage, easy to repair, and it will be found that no one out East will cavil much at either watts consumption or price."

THE CANAL INQUIRY.—I.

The Royal Commission on Canals and Waterways appointed to inquire into and report on the canals and inland navigation of the United Kingdom, has now issued its fourth and final report (England and Wales and Scotland), forming Vol. VII. There are four more to come—viz., Vol. VIII, containing the appendixes to the last; Vol. IX, the report of Sir John Wolfe Barry and his partners on the cost of improving the "cross," as it is called, which will contain many plans and sections; Vol. X, a report by Mr. R. B. Dinwoody, Assoc.M.Inst.C.E., on the available water supplies for this same "cross"; and, finally, Vol. XI, "The Report on the Canals and Inland Navigations of Ireland," though it is not very clear why another Irish grievance should have been created by bringing in the Emerald Isle last of all.

The Royal Warrants appointing the Commission were signed on March 5th and August 8th, 1906, by Mr. H. J. Gladstone, and the first sitting took place on March 21st of the same year. Since then 106 sittings have been held by the Commission itself, besides numerous meetings of the three Committees on Foreign Waterways, Engineering and Water Supply, and 266 witnesses have been examined. The Commission have had some pleasant outings on the Continent of Europe, but did not go any further east or west, or study in any way the very ancient canal systems in China and the very successful ones in the United States. Mr. William Heerlins Lindley, M.Inst.C.E., was appointed Assistant-Commissioner on July 13th, 1906, and his excellent report upon French, Belgian and German Waterways, with maps, &c., is printed in Vol. IV. Various maps are spread over the different volumes, which will form a useful work of reference for the "Development Commissioners." The probable final cost of the inquiry is not even adumbrated, while the Commissioners calmly recommend that the execution of the scheme they elaborate be postponed for further consideration. On this Mr. J. F. Remnant, M.P., remarks in his separate report:—"In the course of the inquiry, which has lasted for nearly four years, sufficient material has been laid before us to enable a final decision to be formed upon the questions raised by the terms of reference."

Mr. Remnant's report is a short and very pithy one. The only part of the majority's opinions with which he agrees are the recommendations relating to Scotland. He also approves of the introductory remarks of the historical portions; this is but faint praise. Mr. J. C. Inglis, Pres. Inst.C.E., general manager and consulting engineer of the Great Western Railway, has submitted a long and exhaustive separate report, and he only approves of the Scotch recommendations; all the others he cuts up unmercifully. Lord Farrer; Sir John Wilson, chairman of Wilsons and Clyde Coal Co., Ltd., Glasgow; Mr. Laurence A. Waldron, M.P., chairman of the Grand Canal Co., Ireland; and Mr. H. F. Killick, director of the Leeds and Liverpool Canal Co., have signed a "reservation" which practically damns the most important and essential opinions expressed in the majority report; in fact, it is rather difficult to understand why these gentlemen signed it. Lord Farrer also gives an "additional note" of his own, which is worth quoting from separately.

Subject to the above "reservation," his Lordship signed the report "because the larger part of it contains much useful history and description"; this, again, is rather faint praise. But as a Free Trader, he specially dissents from this proposition:—"It may fairly be held that the State is concerned in ensuring to its citizens by its own action, if private enterprise fails to accomplish this end, the best and most economic modes of transport, so that industry and commerce may be carried on as effectively as possible, especially in view of the strong competition now taking place in the markets of the world. For, clearly, low rates given to certain traders at the expense of the public purse, whether local rates or export rates can only act as a bounty given to such traders." Agriculture makes small use of the present canals; the coal trade is in no special need of assistance from the public exchequer at the expense of the consumer generally; "and more than half the counties in Great Britain would not be touched by the proposed canals, though they would be taxed for them. As regards the export trade to the 'markets of the world,' believing as I do, that trade is always a form of exchange between individuals and not between nations, I can only look upon any suggestions of State aid to particular individuals or traders as a most dangerous precedent." It will be seen that this knocks the bottom out of the majority Report entirely.

The Right Hon. Russell Rea, M.P., merchant and shipowner, makes one reservation, but that is an important one:—"I am unable to concur," he says, "in the recommendation—not only to improve the canals on the routes selected for barge traffic, but to add to the scheme the work of improving the Rivers Trent and Severn, so as to admit sea-going vessels of 750 tons to Nottingham and Worcester, and of 600 tons to Southport." If these works be left out, but very little remains of the whole scheme. If the river works should become advisable later on, Mr. Rea very sensibly observes that "it might then become reasonable to improve . . . the river, and in such circumstances it would also be reasonable to expect that the trade and locality to be benefited should bear the cost." Very true but not at all what the majority recommend.

Mr. R. C. H. Davison, M.Inst.C.E., the consulting engineer, agrees with Lord Farrer's views on local contributions, and he submitted a separate report to his Majesty, in which he dissented from the majority report in important particulars, and to such an extent that none of the recommendations appear to be left with a leg to stand upon. Not only that, but Mr. Davison finds that three vital principles, without which the success of the Continental waterways could not have been secured, are absent from the recommendations in the Report. He agrees, however, with those relating to local rating; to alterations in the laws or principles of procedure; and to Scotland.

With regard to the "Historical Sketch" given in Part I of the Report, Mr. Inglis seems to be justified in dissenting from it on the grounds that it is incomplete and appears to seek from the outset to raise a certain degree of prejudice against the railway companies in regard to their relation towards the canals. In fact, the railways have always been considered a fair target, and, as in the case of the large blue-bottle flies that filled the butchers' shops, they are charged with a rapaciousness which has killed trade, has ruined the country, and has done no good to themselves in the process. As Mr. Inglis puts it, efforts have been made to throw the responsibility for the present depression of trade on the railways, and it has been implied that if they could be forced to reduce their rates by State-aided canal competition, there would no longer be any reason or excuse for Tariff Reform. Moreover, as in the case of some of the proposals during the "Development" discussion in the House, when it was suggested that the competition of the road with the railway should be encouraged, any prejudice done to the capital value of the latter through the instrumentality of the canals would enable the State to make a better bargain later on if it should ever want to acquire the railways. Probably unconsciously, to a certain extent, the Commissioners have written as if they held a brief in favour of the canals as against the railways, whom they regarded as opponents, instead of as co-partners in the improvement of transport facilities.

The canal companies, when they took the place of pack animals, and later of heavy wains, were enabled to charge such enormous rates that they quickly waxed very fat indeed, with the result that many little wild-cat schemes were started which would, no doubt, have been absorbed in the larger undertakings (as happened later with the railways), had not the railways come upon the scene, suddenly and unexpectedly, acting the same part towards the canals as the latter had done with regard to the roads. The rich canal companies employed the enormous funds they had accumulated in fighting the new railway companies tooth and nail, and like the local authorities in dealing with tramway companies, they extorted the most exorbitant sums as the price of the withdrawal of their opposition—such prices being often the cost of purchasing the canals themselves.

The acquisition of canals by the railways has had a beneficial effect in many cases, nor has it been proved that any railway has deliberately killed any canal it had bought which would not have died a natural death anyhow. In

fact, some of these moribund waterways have been kept alive by the railways solely under the obligations of the purchase agreements. Had they been in the hands of independent companies they would have been abandoned long ago.

That canals have some very great advantages cannot be denied, although the Commission has not made the best of them. These were set out in these pages just two years ago, and may be briefly referred to with advantage. Taking, as an example, the figures for 1898, the canal-miles then opened were one-fifth in length of the single lines of railway, had only cost one-twenty-sixth, and carried 10,000 goods tons per mile yearly, as against 11,000 tons on the railways. Canals are at their cheapest when worked to their maximum capacity. Their maintenance charges do not increase with the traffic; traction on them, if carried on in a scientific way, is cheaper than by any other means, except, perhaps, by aviation. There is a certain speed, having reference to the waves of translation, by which the traction force required is marvellously reduced, no wash being produced, and if the example of the Chinese were followed, and articulated trains of barges (with hollow sterns and rounded bows fitting into one another) were employed, with electric traction—if all these means were employed, canal traction would be made to pay, however narrow and tortuous the waterways might be. Moreover, a multiplicity of locks might be avoided by substituting for them, inclined lifts or portages, over which the trains of barges might be taken without uncoupling them; these portages might be worked by electricity, which would also be used for lighting up the canals, and so doubling their capacity. The traffic, whether on double or single lines, might be worked as on a railway. In either case there should be a tow-path on either side; no other method of hauling should be permitted on the same length, and all traffic should be moved at a uniform speed.

None of these improvements, except electric traction, are suggested in the body of the Report, and only one inclined lift is incidentally mentioned. Mr. Lindley, in his report, alludes to the electric traction installed in France on the Canals d'Aire, de la Deûle, and the diversion of the Scarpe, where electric tractors running on the tow-path are used for a distance of 36 miles. The Northern Electric Co. have obtained a concession to establish electric traction on a crowded part, 55 m. in length, of the St. Quentin Canal. As other and existing methods of hauling over the same stretch have not been stopped, the concession is not worth much, although it is for 40 years. There is a saving clause, however, viz., that the State has control over the tariffs and *operations*, as well as a right to purchase. The Chamber of Commerce of Donai has made a better bargain, having secured the *exclusive* right of traction, which will be electric, for a term of 50 years.

In Germany electric towage by traction on the bank has been established on the Teltow Canal by the district authority who own it, and other forms of traction are not permitted to cargo boats. In a report of the Special Committee of the German-Austro-Hungarian Society of Inland Navigation, laid before the Inland Navigation Congress at St. Petersburg in 1908, they expressed themselves as unanimously in favour of electric towage from the bank as "the most suitable means of economical exploitation of the canals," if used by a monopoly. It has not yet been decided whether electric towing from the bank shall be used throughout all or any part of the proposed new canal from the Rhine to Hanover. "The probable towing costs and the charges on traffic which they would involve have, however, been made the subject of very careful calculations as a basis of the project by the Siemens-Schuckert firm in collaboration with the Prussian Government. It is calculated that certain not very high charges upon the traffic would cover the interest and redemption charge on the cost of installation and the expenses of working and maintenance." The discussions at the recent International Inland Navigation Congress show that the tendency of European and American engineers is to accept electric towing as the best and most economical on canals (as distinguished from broader waterways) where the present or prospective traffic justifies the expense; the advantages being greater regularity and uniformity of speed, compared with traction by tugs; less wash on the banks; electric power when once established can also be used for lighting, operating locks, and even for working riparian factories. The necessity has also been insisted on for excluding other means of haulage and for uniform speed—this is almost self-evident. It follows that the organisation of the working of the traffic should be in the hands either of the owners of the waterways or in those of concessionaires. Prof. E. W. Marchant, who has made a special and practical study of electric traction at the Liverpool University, has come to the conclusion that even if the electrical system be no more economical than haulage by steam tugs, it is decidedly to be preferred on account of the auxiliary advantages which there are in using it.

The Commissioners state that they have dealt at some length with this question of traction because, if a large improvement of British waterways be undertaken, it will be a matter of great practical importance to inaugurate from the first the system best adapted to suit modern conditions, and yet they have made no provision in their estimates for the provision of electricity in any shape or form or for any purpose whatever.

(*To be concluded.*)

SALE OF SCRAP METALS.

By INTERESTED.

What is the correct method of allocating moneys received from the sale of old metal in a municipal supply station? Strictly speaking, correct allocation is almost impossible. When trying to solve the difficulty, that little "if," which continually intrudes, is such a source of annoyance that to lay down hard and fast rules is nigh an impossibility. Every instance seems to differ somewhat in detail from all previous transactions of a similar nature.

Let me give a concrete example by way of explanation. Suppose about 3 tons of scrap copper-wire or bars (devoid of insulation, of course) and a similar quantity of lead, have been sold, the money received for the same being about £200. The question arises to which account should that sum be placed? Some people will say off-hand, "Why, capital account, of course," whilst others, perhaps, will favour the whole sum being used to relieve revenue, saying that because the value of the cable, &c., was, in the first instance, booked out as a capital item, any replacement should be borne by revenue, and the money thus received for the old metal should go to revenue account. Strictly speaking, neither is correct, because, although the value was originally charged to capital, yet a certain portion of the loan or loans by which the money was obtained in order to purchase the goods has been redeemed. Therefore, placing the whole amount received for the sale of old material to capital or revenue seems, on the face of it, to be wrong.

How, then, is it to be allocated? Obviously it is quite impossible to keep a complete record of the length and size of each short length of wire or cable scrapped, so as to enable the exact proportion of the cash now returned, as it were, to be placed to either account. Even were such a method adopted, another query would arise as to what is to become of the balance of the loan outstanding after deducting therefrom the sum now received, plus the total repayments to date. This splitting of hairs would but lead to confusion, and I certainly think that all moneys received in this manner for the sale of old metal should go to revenue account. At the same time it would be well to consider the advisability of paying for all small extensions, where copper or lead would be present in large quantities, out of revenue, so as to overcome the difficulty which would undoubtedly present itself in the future were no notice taken of the remaining portions of the cable loans not redeemed, as in course of time the outstanding balances would grow to a size dangerous to the financial stability of any undertaking. This would more forcibly apply where large quantities of metal were being sold.

The same argument seems to apply equally well to any scrap metal so disposed of. Take, for instance, old valves, or any article composed more or less of the more expensive

metals. Invariably these would have been purchased originally out of the capital account, and the loan raised for the purchase of same would not nearly have been repaid. In all such cases the moneys thus received should be placed to revenue, because a certain portion of their first cost has been paid out of revenue, and most likely in a number of instances, certain small additions have been made at the expense of the same account, thus helping to balance matters.

The cause of the difficulty, if I may term it such, is the same on this occasion as on others, viz., that the period allowed in the beginning for repayment of principal has been proved by experience to have been far too long. As time goes on, no doubt things will become more and more improved, especially under the lately inaugurated, and shorter, terms laid down for repayments.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Cast-Iron Brake Blocks.

Your article *re* cast-iron *versus* wood for track brakes, and Prof. Wilson's experiments, rather gives the impression that the conclusions arrived at are new. May I point out that at the Leeds Conference in September, 1906, I called special attention to the matter (see page 67, *Proceedings* of the Municipal Tramways Association, 1905-6) in the following paragraph in my paper on brakes :—

"This brake was erected on a locomotive we were building at the time, and its performances were so satisfactory that it was resolved to adopt it for the Manchester road cars ; and here I may say, for your information, that during the trials it was found that it would be unsafe to use wood for the slippers, and that soft grey cast-iron was the only suitable and safe material."

The conclusions of the Brakes Committee of the Municipal Tramways Association are too recent to need quoting, but I ask you to publish the further results obtained by Mr. Fell and Mr. Spencer, and reported on September 21st, 1909, viz. :—

MUNICIPAL TRAMWAYS ASSOCIATION.

To the Executive Committee, Municipal Tramways Association.

BRAKES REPORTS.

We beg to submit for the information of the Executive Committee the conclusions which we have arrived at after making the further experiments suggested by Colonel Yorke at the Committee's recent conference with him.

As a result of these experiments, we are of opinion that many of the apparent discrepancies between the figures given for the coefficients of friction of various materials in the Reports of the Brakes Committees of the Tramways and Light Railways Association and the Municipal Tramways Association respectively, are explainable when certain differences between the materials tested and the conditions of test are taken into consideration.

The general indication of the experiments is undoubtedly that cast-iron of a reasonably soft grade is superior to wood as a braking medium, under the varying conditions of rail met with in practice.

Dry wood track-brake blocks may afford a considerably higher coefficient of friction than cast-iron on a dry rail, and may possibly give a nearly equal coefficient on a wet rail if thoroughly impregnated with sand, but it is certain that, with or without the use of sand, cast-iron may be relied upon at all times to give a practicable coefficient while, under certain conditions of rail, the friction afforded by a wooden track block may be very low.

We would point out that the figures given for the relative values of the frictional coefficients of metal and wooden track-brake blocks in Appendix I—"C" of the Tramways and Light Railways Association Brakes Committee's Report, are comparable with those given in the Report of the Brakes Committee of the Municipal Tramways Association, and also with the results of the later tests which were undertaken by us in London and at Bradford.

A. L. C. FELL,
President, Municipal Tramways Association.

CHRIS J. SPENCER,
Vice-President, Municipal Tramways Association.

September 21st, 1909.

As a matter of history, please also reproduce the following paragraph from my last annual report :—

"Burnley Corporation Tramways Committee were the first in this country to use cast-iron for track shoes, and the discovery that cast-iron and not wood was the proper material was first made on the electric locomotive built in our own works in 1903."

I think it is due to myself as well as others that the important facts ascertained after so many years' experience and examination should be placed fully before your readers, and I shall be very pleased if you will publish this matter in full.

Henry Mozley.

Burnley Corporation Tramways,
January 5th, 1910.

Electric Smelting of Tin Ore.

I should be obliged if any reader could tell me whether it is possible to obtain such metals as tin from their ores by smelting in the electric furnace, and, if so, whether there is a furnace on the market for such a purpose.

Smelter.

The Single-phase Motor.

With reference to my letter of October 20th, 1909, regarding the adaptability of the single-phase motor to a general engineering works, I should be greatly obliged if the writer of the article entitled "A New Type of Cascade Induction Motor," appearing in the ELECTRICAL REVIEW for October 22nd, 1909, would give his opinion on this subject, particularly with respect to the suitability of such motors as that with which the above-mentioned article deals.

Advocate.

Morecambe Electricity Supply.

Looking over the records of the above scheme, we find that financially it is a ghastly failure, the yearly deficit from 1898 averaging almost £2,000. Lately, Mr. W. R. Wright was appointed consulting engineer, presumably to advise the Council. However, his advice has been rejected by 14 votes to 7. As an electrical engineer, I would like to ask for what reason a consulting engineer was ever appointed by this very extraordinary Council? They evidently appear to know far more concerning the business of electricity supply than Mr. W. R. Wright, and it, therefore, seems a pity to further burden the undertaking and ratepayers by paying the latter gentleman. The Morecambe Council pay their electrical engineer £150 a year to take charge of a 700-KW. plant, whereas the engineer of the neighbouring and smaller plant belonging to the Fleetwood Council receives £225 per annum, rising to £300. It is, considering the above facts, quite easy to see why the Morecambe electricity supply is such a white elephant, and the best thing the ratepayers can do is to change their present Council for a Council of business men at the earliest opportunity. Mr. Wright and their underpaid resident engineer have my sympathy.

A.M.I.E.E.

Methods and Practice in the German Electrical Industry.

The German gentleman (self-identified with the meter industry) of Free Trade proclivities hailing from Birmingham, "surprises by himself" a triad of anomalies which are remarkable to a student of the effects of environment upon temperament.

He does not profess to be a political economist, and is another shining example of the person who is apt to err when attempting to deduce a disinterested conclusion from a set of phenomena which he does not understand.

Let "Zähler" return to the prosperous country whence he derives his cognomen, and he may yet live and learn.

Ramfox.

[Our correspondent "Zähler" is an Englishman by birth and descent, and has had many years' experience in the meter and allied industries.—EDS. E.R.]

"Electric" Fires.

As you have from time to time called attention to the absurd way in which fires are attributed to electricity, we send you herewith a copy of a letter we have had to send to a number of papers, which had attributed a fire at Rockcliffe Park, near Darlington, to electricity; and as this report appeared in many London papers, and no doubt throughout the provinces, we should like you to give this letter publicity.

Cox-Walkers, Ltd.
E. Cox-Walker, *Director.*

Darlington, *January 7th*, 1910.

[COPY.]

January 7th, 1910.

Rockcliffe Park Fire.

Dear Sir,—In your issue giving an account of above, it is stated that the cause of this fire was supposed to be a fusion of electric wires, and as it is becoming a too common practice to ascribe unknown causes of fires to electric wiring, we should be glad if you will make it known that in this instance the fire has been clearly traced to a faulty chimney flue, and that so far from electric lighting being the cause of the fire, it was actually the means of giving the first intimation, through some lights going out, that something was wrong, and it was not until our men, who were engaged on other work in the building, went into the false roof to ascertain the cause that the fire was discovered, which had already been smouldering for many hours, if not days.

In the interests of electric lighting generally, we shall be glad if you will publish this letter.—Yours faithfully,

Cox-Walkers, Ltd.

PROCEEDINGS OF INSTITUTIONS.

Metallic-Filament Lamps: their Possible Beneficial Effects on Supply Undertakings.

By G. Wilkinson, Member, and R. McCourt, Associate Member.

(*Abstract of paper read before the* Institution of Electrical Engineers *at Leeds, December 15th*, 1909.)

In this paper it is intended to give some idea of what has been done in Harrogate to counteract the effect which the introduction of metallic-filament lamps has produced in a system where the bulk of the demand on the station is for lighting purposes, and where the supply is alternating current, conditions which admittedly favoured the largest possible use of the new lamps in the shortest possible time.

It was felt that as consumers are naturally chary of introducing new lamps before being fully assured of the reality of the claimed advantage, the anticipated large adoption of them was bound to be gradual, and it was, therefore, decided not to recommend an increase in the price, but rather to adopt a policy which would educate the public to appreciate the economy and possibilities of the new lamps.

By way of experiment a 17-ampere open-type A.C. arc lamp, which had been in use over 12 years, was displaced by a 4-arm fitting having four 100-C.P. metallic-filament lamps. The general public and the local Press expressed themselves in favour of the incandescent lamps, and instructions were given to convert the greater part of the arc lighting of the town to the newer form of illuminant. Eighteen arc lamp-posts were fitted each with two 100-C.P. 200-volt metallic-filament lamps, and two with four 100 C.P. lamps. The lamps are not enclosed, but are exposed to the atmosphere, and this condition has undoubtedly tended to increase the life of the lamps. Each arm is fitted with a 13-in. holophane reflector. The roadway in which these lamps are fixed is in a residential district, and is now considered to be adequately lighted, the inference being that with the arc lamps it was over-lighted. Although they had been burning for, say, 1,000 hours, the renewals in that time had only amounted to seven out of 46, and of these two were due to a motor-van.

Careful photometric tests show that the same average illumination is obtained at the following average distances:—

Arc lamp (17-amp., open-type, opaline globe) ...	28½ ft.
Four-light fitting	27½ „
Two-light fitting	21½ „

The cost of the alteration of the 20 arc lamps to two and four-arm fittings, including ornamental arms, reflectors, lamps and all labour, and without any allowance for scrapped material, was £91. No alteration in the mains was required.

The cost of current at 1½d. per unit and maintenance per annum for the lamps is shown below:—

Arc Lamps.		*Metallic Lamps.*	
Current	£169 0 0	Current	£56 0 0
Trade account ...	22 0 0	Renewals	29 7 4
Wages	61 0 0	Wages	6 10 0
	£270 0 0		£91 17 4

It is evident that the capital cost of making the alteration is more than met by the saving in the running costs of the first year.

The smaller metal lamp forms a most effective competitor against the incandescent gas mantle for side-street lighting. Many photometric tests of gas mantles in the roadways have proved that the average candle-power of a 3-ft. gas mantle does not exceed 30 candles, while, with metallic-filament lamps 30 C.P. can be obtained for 33 watts. Taking the price per unit for street-lighting purposes at 1½d., and the price of gas at 2s. 2½d. per 1,000 cb. ft., the cost of 30 C.P. for 1,000 hours with electricity is 4s. 2d., against 6s. 8d. for gas; the renewals in the case of electricity (assuming the life of the lamps to be 1,000 hours) cost 3s., and for gas (assuming the life of the mantles to be 400 hours) cost 10d., making the totals—electricity, 7s. 2d., gas, 7s. 4d. These figures do not include the extra cost of labour in the renewals of the gas mantles nor the cost of breakages of chimney glasses, which frequently occur, nor extra cost of cleaning the gas lanterns.

The convenient way for the metal lamps to be installed is in a lampholder screwed on the end of a vertical pipe standing up in centre of the lantern, with the lamp cap downwards.

The private consumers were not slow to adopt the metal lamps. The effect was noticed first in the business part of the town, where the shops are chiefly supplied at 100 volts. A number of installations were reconnected which had gone back to gas. The general effect from this class of consumer was not apparent in the reduction of the number of units sold so much as in a generally increased illumination. However, as the average householder began installing transformers to reduce the supply pressure to 25 or 50 volts, it was found that the output was decreasing.

As an instance of the use of metallic-filament lamps at low voltages, a large hotel in Harrogate, which adopted this method, in the year ending December, 1906, used 13,712 units, while in the year ending December, 1908, it increased the illumination and used only 7,672 units. But although 30,000 to 40,000 metal-filament lamps have been disposed of in Harrogate, the number of units sold for lighting purposes for the year ending March, 1909, was only 5 per cent. below the figure for the year ending March, 1908, and the figures for units sold for all purposes are only down 2·5 per cent. It was felt that some steps ought to be taken to introduce electric lighting into the smaller houses, and thus tap a source of revenue which the gas companies have found so remunerative; but unless cheaper services could be installed, the revenue from such consumers would scarcely do more than pay the interest on the capital costs.

It was decided to offer a contract system of charging on the following terms:—

1. Consumer must supply his own lamps.
2. Each apartment in which a lamp is installed must be adequately lighted by windows in the daytime.
3. The maximum number of lamps to be alight at one time to be declared at the commencement of the contract.
4. The minimum number of lamps applied for to be two and the maximum six, each taking 30 watts.
5. The charge to be 2s. 9d. per quarter per 30-watt lamp, payable in advance.

Clause I tends to counteract the temptation to use the light more than actually necessary, because of the cost of renewals of these comparatively expensive lamps.

Clause III enables the department to install a current limiter which causes the lamps to flicker if more than the number contracted for is switched on.

A safe margin is left to balance the more free use of the supply which it is only natural to expect will take place.

The current limit indicator which has been adopted is of a simple thermal type, compensated for variation in atmospheric temperature, and is made by a well-known firm of instrument makers in London.

The advantages of the contract method of charging for a supply of electricity on these lines are as follows:—

1. Consumer knows exactly what the amount of his quarterly account will be.
2. Consumer can have the use of the light in every apartment.
3. The supply authority is saved the cost of demand indicators, half the cost of the meters, and the continuous expense of repairs and recalibrations, excitation current and meter readings.
4. The book-keeping is simplified, and the risk of incurring bad debts is banished, due to the payment being made in advance.

It has been found that, if builders are induced to wire their houses, the tenants are extremely anxious to avail themselves of the use of electricity; and on one new building estate, where 100 to 120 houses are being erected, of the value of £20 per year or less, an agreement to supply on the contract tariff has been entered into, while the builder has agreed to wire the whole of the houses as they are built.

It was found that the average cost of services and accessories, including meters, in Harrogate was nearly £7. The interest on this sum at 10 per cent. is 14s., and if the service to a small house paying 22s. per year for two lamps was to cost that sum, there would only be left 8s. to pay for the current consumed. It was decided that a 5-ampere cable costing £50 per mile would be of ample capacity to serve the smaller houses. The cut-out box of 25-ampere size was displaced by a smaller box costing 4s. each. The current limiter only costs 15s., as compared with the former price of 35s. to 40s. for a meter. The cost of labour is reduced by one-half, and it is conclusively proved that the cost of all these does not exceed 45s. to 50s.

It is impossible to refrain from referring in the strongest possible terms to the unenterprising attitude of the cable manufacturers to our request for a cheaper service cable. It was only after a lot of correspondence and several interviews that the special

concentric cable which is now in use, was evolved by a well-known firm at the price of £50 per mile.

Our efforts to popularise the metallic-filament lamp, while they tend to decrease the amount of energy used by the old consumers, have enabled us to win over additional consumers, and we lately have frequently had the satisfaction of seeing our monthly generation sheets showing an increase as compared with the previous year.

MR. T. HARDING CHURTON, in opening the discussion, said he did not think that many people would wilfully waste their lamps (especially the more expensive metal-filament lamps) as well as the current, and even if they did so, it would not very much matter to the supply undertaking.

MR. A. J. CRIDGE said the price of supply should not be raised except in the last resort, and to raise it now would be suicidal. To increase the price to users of wire lamps only was also, in his view, illegal. Mr. Wilkinson's street arcs, which had been replaced by wire lamps, seemed to have been of an obsolete type, and the comparison given would have been more valuable if it had been against modern flame arc lamps. He protested strongly against the suggestion that gas at 2s. 2½d. per 1,000 cb. ft. was equivalent to electricity at 1½d. per unit. Probably the special lamp mentioned by Mr. Wilkinson would be very costly, and would have too restricted a sale to tempt the manufacturers to take it up. In Sheffield, as in Harrogate, they had recovered many of their old consumers who had gone over to gas. Shops and public houses of not quite the first rank formed the majority of these cases. They had not encouraged consumers to reduce their pressure below 100 volts. It was a mistake to go even as low as 50 volts on existing wiring; 50-volt installations should be carefully laid down, and all wires should be ample in size—25 volts was unnecessarily low, and the cases must be few in which such a low-pressure served any good purpose. If a transformer were used, he had often found in his own experience that the magnetising watts, at 4d. per unit, might cost the consumer £4 or £5 a year. As to contract rates, it was very much open to question whether they were ever justified or not. He thought it unwise to go in for much formality, or red tape, or limitation of any kind. Mr. Wilkinson fixed a maximum of six lights. Would he refuse an application for seven? He would not be inclined to trust a consumer to turn out his lamps when they were not needed. The check devised by Mr. Wilkinson, in Clause 1, viz., the cost of renewals, would not help at all; at low voltages the life of the wire lamp was to be measured in thousands of hours, so that one might leave it alight all the year round without great expense in renewals. At Sheffield the units consumed in meter shunts were about 1 per cent. of their total sales, and their cost to the department was less than ·067 per cent. of the total revenue. If all the meters were modern, these figures would be reduced by two-thirds. Referring to service costs, theirs was down to £4. He thought the right system of charging in the case of private houses was one consisting of a fixed sum per annum, together with a small price per unit. The fixed charge must *not* be based upon the installation, because this practice tended to prevent the fixing of electric light in places where the light was not seen much. The price per unit should be of the order of 1d.; then kettles, irons, and stoves could all be attached to the lighting circuit. Here was a reason for not reducing the pressure too far, for a 50-volt iron took 10 amperes. The system in vogue at Norwich, due to Mr. F. M. Long, commended itself to him, the fixed charge being based upon the rateable value of the house.

MR. S. D. SCHOFIELD said that if the author was obtaining as good a light for 200 watts now, as he did from a 17-ampere arc lamp, the efficiency of the arc lamp must have been very low indeed. It would be interesting to know the relative heights of the lamps above the ground. In some towns where they had heavy street traffic, particularly heavy electric cars, the vibration in the street had a disastrous effect on the filament of the lamp, and he would like to know if the authors had any experience with flexible suspension. The drawback to their method of charging was that it took no account of heating and cooking apparatus. With the present low rates for this purpose, there was a large field open for the supply engineer. In many cases consumers would put radiators in if it were not for the cost of taking the duplicate set of wires back to the meters, and for that reason the "telephone" method of charging, or the Norwich system, were superior to Mr. Wilkinson's method. They must find some load to level up the decreased consumption due to the metallic lamps, and it was only by heating and cooking and power use that they could get this result.

MR. R. H. CAMPION said the cost of the services was, to his mind, fairly large. He found difficulty in getting from one house to another, even when they were adjoining. In most districts the holophane shades got a deposit on them, especially in industrial towns, and this took away a considerable amount of light. If anything could be done to get down the cost of cable it would be a big step in the right direction. His experience in lighting cottages had not been very successful. The tenants would not replace a lamp costing 9d., no matter what condition it was in, so he was afraid the extra cost of metallic lamps was going to be a serious thing. The Northern Counties Supply Co. tried doing without meters some ten years ago, and with disastrous results. Although they had reckoned on a man only having his light on a certain length of time, they found that the colliers never switched it off. All heating apparatus people agreed that they must not go below 100 volts, as the apparatus could not be made successfully under that. It was the cost of installing that was keeping the people back. The gas people were "in" with gas cookers and radiators, and it was very difficult to displace a thing when once in. The Norwich system was extremely difficult to work in a good many towns.

PROF. G. D. ASPINALL PARR said it appeared to him that a working man with a house of, say, 7s. 6d. weekly rental, would think twice before he bought, say, six lamps costing something like 15s. It seemed to him that but for the additional initial cost, meters would have been a great deal better, as a working man did not feel a penny going out at a time as he would 15s. or £1.

MR. H. DICKINSON said he had got out a curve showing the additions of lamps and deductions due to changes from carbon lamps to metallic-filament lamps, which showed that from the end of 1907 to September, 1909, they had had more deductions than additions, but the last three months had shown increases over and above the deductions. Metallic-filament lamps in Leeds had been extensively adopted, and he believed they would ultimately prove a great benefit to the supply undertaking. With regard to the new system of charging, he took it that the type of house concerned was about £20 per annum rental; they had connected already 700 or 800 houses of this type in Leeds, and the only advantage he could see in the scheme was that the consumer knew exactly what he was going to pay. He could see no other advantage compared with charging a consumer through a meter in the usual way. The sample of cables mentioned, costing about £50 per mile, did not appear to be sufficiently mechanical.

MR. J. W. HAMM said the question of the method of charging had exercised his mind a great deal. He had tried contract demand, maximum demand, flat-rate and other systems, and was gradually coming to a definite conclusion that whatever was ultimately decided upon, it was bound to be some method in which measurement of the current was made. A system which answered very well in certain cases was the two-rate system, but the apparatus was costly. He was puzzled greatly to know how central station engineers were getting to know the number of lamps connected. He kept a record of the additions made each month, but he questioned the value of that figure, as indicating the lamps connected. One very important item was the cost of putting in services, he could not reduce it below £5.

MR. J. F. FAWCETT said with regard to obtaining the lighting service, one reason why the gas company got the load, was because they worked for it. The station engineers did not pay sufficient attention to the builders, who informed him that the gas people were continually worrying them until the fittings were put in. The cost of the wiring was just as likely to prevent these small houses coming on to the mains as anything else. The heating question was worthy of serious consideration. One station in particular in the North of England had 2,000 or 3,000 KW. of heating; figures like that were worth trying for.

MR. G. WILKINSON, in reply, said Mr. Dykes wrote him as follows:—"You will be interested to hear that we have started our fixed price light company here, where we are wiring the poorest houses and making a charge of 3d. per lamp per week to cover the unlimited use of the light. The wiring is concentric, carried out in Stannos wire, and the cost, including fittings, but exclusive of lamps, is just under 8s. per point, including the main fuse." Surface wiring at 8s. per light, including everything except lamps, was about as low a price as he had come across. He found the cost of wiring to be 9s. per point as a minimum; then there was a charge of 5s. for the metallic-filament lamp, pendant and shade, making a total of 14s. per light complete and ready for use. To check a number of contract customers they inserted a meter and demand indicator on the supply main, and from readings taken over several weeks they concluded that the average price per unit obtained would be 3d. over the whole year. Prepayment meters were costly and troublesome to maintain. They soon became full of coppers if a large amount of light was used, and it was necessary to send someone to remove the coins, as the meters became jammed and the supply cut off, or, worse still, the circuit was not broken and the users got further supply free. The margin they allowed for running charge was sufficient to prevent loss, even with an excessive use averaging eight hours per day. They made a reasonable profit, and no bad debts, as the money was paid in advance. He agreed that the use of flame arcs was good practice in the business part of a town where the traffic was dense, but in a residential town like Harrogate, the metallic-filament lamp gave quite good results. The contract system did not interfere with the wiring of the bedrooms and other apartments; it did not matter how many lamps a man had wired, so long as he did not have alight more than the number of lamps contracted for. The efficiency of the 17-ampere arc lamps was not good, as the lamps were old. The arc lamps were placed 20 ft. high, and the incandescent lamps which displaced them, 2 ft. lower. The latter lasted fairly well, but they were in doubt whether the breakages were due to the lamps being upside down or to the lamp cleaners being careless and breaking them. He preferred metal lamps put up without lanterns. Prof. Parr thought the 15s. for lamps, &c., was excessive for a working man; but if the man did not provide them he had to find something for gas fittings, and there would not be much difference in the cost. The 50s. for service cable, &c., included everything, as each service served as a minimum two semi-detached houses, and the cost of the service was spread over the two. The Harrogate output was not at present increasing; there was, however, an increase last summer over the corresponding quarter of the preceding year, but the output for the seven months ending September was 2½ per cent. down.

MR. R. MCCOURT said, with reference to the consumers supplied on the contract tariff, they had lately fixed a demand indicator on a main which served a large number of them, and found from the reading of that instrument compared with their possible maximum demand, that the diversity factor of this class of consumer was as high as 1·8. This result rather surprised them, as they fully expected

these consumers would as a rule use all their lamps every night, but they evidently did not. They would have preferred flame arc lighting in the business part of the town, but the Street-Lighting Committee decided otherwise. They had had one of the latest type flame arc lamps, taking 350 to 400 watts, fixed on a standard lamp pillar, and their photometer test gave the same average illumination as that previously referred to at a distance of 41 ft.

Continuous-Current Boosters and Balancers.

By W. ARTHUR KER.

(*Abstract of paper read before the* INSTITUTION OF ELECTRICAL ENGINEERS, *Glasgow, December 14th*, 1909.)

IN the case of a small two-wire network for a small town, the generating station is usually at some distance from the consumers, and a feeder (or feeders) becomes a necessity. The natural method is to lead a two-wire feeder to the mid-point of the network and supply the network from there, and it would be possible to regulate the voltage at the feeding point by shunt regulation of the dynamo. It may be better to put in a booster to compensate for the drop in the feeder, and to keep the bus-bar voltage constant.

A series-wound booster which required no regulation would be installed. The field winding must be such as to compensate for the drop in both the positive and return of the feeder, and to compensate wholly or partially for the drop in the distributors.

This is the cheapest type of booster, and it is quite satisfactory so long as there is only one feeder, but it cannot be used in conjunction with another similar booster and feeder unless certain precautions are taken, as the return current will divide in the two negatives of the feeders in inverse proportion to the resistance of the two paths; by putting the field coils of the two boosters in parallel, the load is divided naturally, so that the feeder nearer to the load takes the greater share, but two boosters of this type, whether with fields in parallel or not, do not give accurate results.

This trouble may be obviated by using double two-wire series boosters—that is, each feeder has one booster in the positive and one in the negative. Each of these boosters must be wound to compensate for the drop in its own half of the feeder.

Boosters of this type, which just compensate for the drop in the feeders, share the load in inverse proportion to the resistance of the load from the feeding points.

The boosters being smaller than a single booster would be, their efficiency is not quite so high, and they are more expensive. They must not over-compensate for the drop in the feeder; if they do, the system is not stable, and one booster may take all the load away from the other. One method of guarding against this danger is to equalise the currents in the field coils of the boosters, by joining them in parallel.

A better plan is to wind the boosters slightly to under-compensate for the drop in the feeders. In this case the more heavily loaded booster delivers current at the feeding point at a slightly lower voltage than the lightly loaded booster. The latter, therefore, tends to give a larger current, and equilibrium is restored. The only objection to this is that at times of heavy load, when the boosters are carrying a large current, the voltage at the feeding points is less than it is at times of light load. To meet this difficulty, it is easy to raise the voltage at the station bus-bars a few volts, and so raise the pressure at the feeding points to that necessary to give the consumers the declared pressure. This does not in any way affect the compensation of the boosters.

In a three-wire system it is not possible to adjust the consumers demands on each side so that they balance; we cannot, therefore, consider boosters in connection with a three-wire system without also considering the balancers.

A balancer consists of two similar machines with their armatures mechanically coupled together and electrically connected in series across the outers of the three-wire system. The neutral wire is brought to the junction of the two armature windings.

It is obvious that to deal with an out-of-balance current of 100 amperes in the neutral wire, it is only necessary to install two machines, each capable of dealing with about 50 amperes.

A simple shunt-wound balancer with the shunt connected directly across the outers forms a very poor automatic balancer. An improvement to the automatic regulation may be effected by cross-connecting the fields of the two machines.

A further improvement may be made by adding a few series turns on the field coils of each machine, through which the current in the neutral is led, these series turns also being crossed.

It is usual to make the series coils of each machine of such a number of turns that they compensate for the armature drop in the machine. Such a compound balancer, with coils cross-connected, forms an automatic method of keeping the voltage on both sides of the neutral approximately constant.

A cross-connected compound balancer will stand up to any out-of-balance current and strive to keep the voltage equal on the two sides, and this may be a source of danger. If, for instance, a partial short were to occur on one side, the out-of-balance current might become so large that the motoring side of the balancer would be overloaded. To obviate this, it is well to put the series coils of the balancer in parallel with a diverter resistance and introduce a fuse, or circuit-breaker, into the branch to the coils. In this case, when an excessive out-of-balance current occurs, the fuse will blow, cutting out the series coils, and the balancer will continue to run as a shunt balancer, and will be able to deal with a very large current, though, naturally, the balance between the two sides will be bad.

An automatic balancer at the feeding point or on the network has been considered, with the voltage across the outers kept constant at the feeding point by extraneous means. Let us now consider the method of keeping the voltage constant at the feeding point by means of a booster.

When there is only one booster, it may be a simple single generator in one of the outers, series wound to add automatically the pressure due to the drop in the positive and negative feeders. Such a booster is quite satisfactory so long as there is only one feeder, but, as explained before with reference to two-wire boosters, it should not be used if there are two or more feeders. We must, therefore, use two separate boosters for each feeder, one on the positive and one on the negative, each compensating for its own part of the feeder. Such boosters should slightly under-compensate for the drop, so that when a second feeder is added, the conditions may be stable.

A commercial booster of this type can easily be made to add voltage in proportion to the current passing through it with a maximum percentage error of 5 per cent. As the drop in a feeder is not likely to exceed 15 per cent. of the dynamo voltage, the error of the double booster is less than 0·75 per cent. of the dynamo voltage.

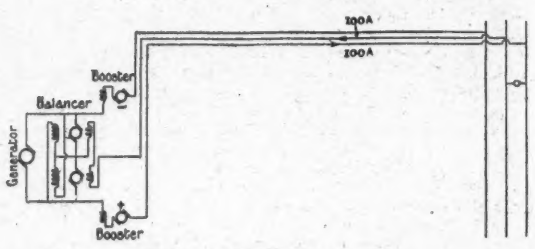


FIG. 1.

As it is unlikely that the percentage error of the positive booster is at its maximum at the same time as the negative booster is at its maximum, the actual combined maximum percentage error will be less than this amount—that is, less than three volts on a 400-volt supply.

Boosters of this type (double two-wire series boosters) are quite satisfactory, however many boosters and feeders may be employed, so long as no one of them over-compensates for the drop on its own feeder.

So far, we have considered the case of a three-wire network with the balancer at the network. The total saving effected by placing the balancer at the network is: No neutral feeder, less copper in the outers, and saving due to drop in the neutral feeder dispensed with.

Against this must be put the objection to placing running plant anywhere but in the generating station, the cost of a special building, foundation, &c., for the balancer, and the cost of sending to oil and adjust the balancer two or three times a day.

Probably the best plan, except in certain special cases, is to place the balancer at the generating station, and to balance the whole system at that point. Take the case of a system balanced at the station with a double-series booster; fig. 1 shows such an arrangement with a single three-wire feeder. Each booster compensates

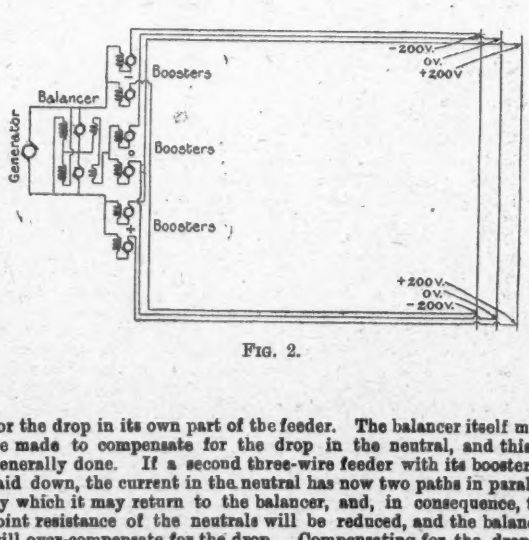


FIG. 2.

for the drop in its own part of the feeder. The balancer itself must be made to compensate for the drop in the neutral, and this is generally done. If a second three-wire feeder with its booster is laid down, the current in the neutral has now two paths in parallel by which it may return to the balancer, and, in consequence, the joint resistance of the neutrals will be reduced, and the balancer will over-compensate for the drop. Compensating for the drop in the neutral by means of the balancer is, therefore, not completely satisfactory, as it restricts us to one three-wire feeder (other feeders being two-wire) or it entails altering the windings of the balancer itself.

Another plan adopted is to use treble three-wire boosters, each booster having three generators—one in the positive, one in the negative, and one in the neutral, the latter, of course, being electrically reversible. Fig. 2 shows a two-feeder system installed on

this plan. This is quite satisfactory in work, but it has the disadvantage that each booster consists of four machines, viz., one motor and three generators.

This system, if designed to compensate for the drop in the feeders, is quite stable, and has the advantage that the potentials at the feeding points are natural potentials, *i.e.*, they are the same amount above and below earth as the bus-bar potentials. In addition, the load divides between the two boosters in inverse proportion to the resistance of the load from the feeding points. The booster feeding to the point nearer the bulk of the load therefore takes the greater share of the load.

Another plan is to use a double booster as before, but with each machine having extra series coils through which the current in the neutral is led. With this type the current in the neutral assists the field coils of the booster on the heavily loaded side, and opposes the field coils on the lightly loaded side. At first sight

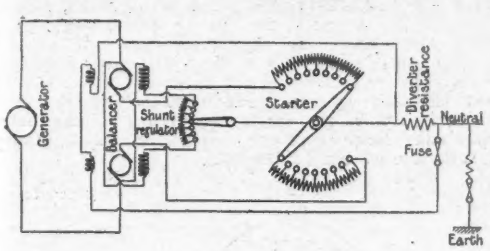


Fig 3.

this would appear to be wrong, and that the booster on the lightly loaded side should be left untouched to obtain correct pressure regulation; but it is necessary to reduce the voltage of the negative booster by as much as we raise the voltage of the positive one. This reduction is effected by the field coil in the neutral wire.

Such a booster compensates automatically for all losses, and it may be run in conjunction with one or more similar three-wire feeders and boosters, but it has certain serious disadvantages. When the out-of-balance load is much nearer one feeder than the other, the booster of that feeder takes not only the whole out-of-balance load, but it also relieves the other booster of part of its natural load. The copper is therefore not used to advantage, and the boosters must be larger and therefore more costly than they would be if this effect were prevented. Under certain conditions this system of boosting becomes unstable, and it cannot be said that the system is satisfactory.

All things considered, the system shown in fig. 2, having three generators, one for each wire, is the most accurate and simple. Its cost is practically the same as that of the boosters with neutral wire coils, as in the one case there are three small generators, in the other case two larger generators with special coils. In one case where the author was quoted alternative prices for the two systems, there was only £10 difference in the cost of the boosters.

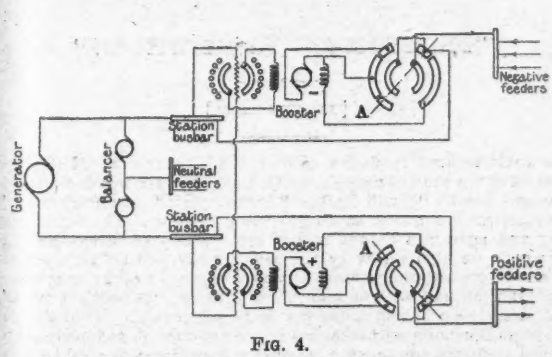


Fig. 4.

An additional advantage is, that all future feeders may be ordinary two-wire feeders having two-generator boosters, and the whole system remains stable, so long as the boosters do not overcompensate for the drop.

In a large town the best arrangement is probably to have two three-wire feeders and boosters feeding to fairly widely separated points, equidistant from the load centre of the network, and to make all other feeders two-wire only. Having two three-wire boosters, one is always available to feed the balancer in case of a breakdown on one neutral feeder or on one of these boosters.

Each two-wire feeder to have a booster consisting of one motor driving two generators, one in each outer.

The motors driving the boosters in each case are better if compound wound, so that a constant speed with any load may be kept on the boosters. With such a boosting system the voltage may be balanced at the station by means of a shunt-wound balancer with field coils cross-connected. The generators should be level compounded, so that the bus-bar voltage may be kept constant, but they should also have some shunt-hand regulation, so that the voltage at the bus-bars may be raised at times of heavy load in order to raise the voltage at the feeding points, and so compensate for the drop in the network.

The essence of stability in such a system is that the pressure at the feeding-points shall not be greater than the pressure at the bus-bars.

With a motor-driven booster, if the motor should come off the line, owing, say, to a broken shunt wire, the booster will be driven as a motor, and may rapidly reach a bursting speed. To prevent this danger a circuit breaker may be used, through the jaws of which the booster-current flows, while the actuating coil is in series with the shunt-winding of the motor. If, then, the motor should come off the line, the circuit breaker will open and cut the booster out of circuit.

Another danger is in connection with compound-wound balancers; the necessity of using a fuse on the path to the series coils in conjunction with a diverter resistance has already been pointed out. Fig 3 shows one arrangement of balancer with fuse and diverter.

In some towns it may be possible so to arrange the feeders that two or more of them may be boosted by the same booster without introducing any serious error. At times of light load the group of feeders is supplied direct from the station bus-bars, and the balancer always deals with the drop in the neutral. It is only when the load has increased to a certain amount that the booster is switched into the circuit; it consists of two generators, one positive and one negative, feeding what one may call high-tension bus-bars, from which the feeders are fed.

On switching in, or out, a booster of the capacity of this one, a decided flicker would show in the lamps, unless special precautions were taken. Fig. 4 shows one method of doing this. It will be noted that the series boosters are also wound with shunt coils excited across the low-tension bus-bars, with potentiometers in the circuit. By adjusting the potentiometer arm the shunt coils can be made to oppose or to assist the series coils, or to have no excitation. The switches A have three contacts, and the method of operation is as follows:—

In the normal position of switch A the current from the station bus-bars passes through the switch to the high-tension bus-bars without passing through the booster. The booster motor is started

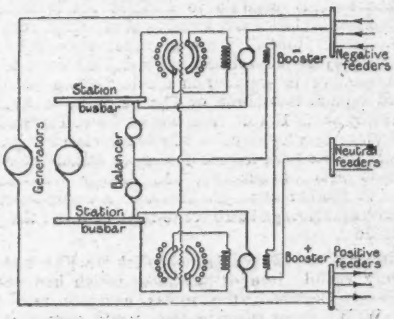


Fig. 5.

up, and switch A is moved to the mid-position. The current now passes through the series coils of the booster on its way to the high-tension bars, and the booster armature shows a voltage, but there is no path through it. The potentiometer is then adjusted to oppose the series coils, until the voltmeter across the armature shows zero, or preferably a very small voltage. The booster is then switched into the circuit. The potentiometer is then moved back to the zero position, and the whole current then passes through the booster on its way to the high-tension bars, and is boosted in proportion to the load.

Some very large boosters of this type have been used. In one case, within the author's knowledge, the booster handles 6,000 amperes.

It does not appear advisable to install such large boosters and incur the loss in the booster motors and generators, when the station dynamos might have their voltage raised and supply the bars direct.

Fig. 5 shows one method of attaining this object. The group of feeders are connected to the high-tension bus-bars, and the dynamos are arranged to be plugged on to either the station bus-bars or the high-tension bars. The dynamos are fitted with voltage regulators operated by means of pilot wires from a selected average feeding point, and thus the voltage on the dynamos and the high-tension bus-bars is raised automatically as the load increases.

If, now, a link is made between the station bus-bars and the high-tension bus-bars, the high-tension dynamos can be kept at full load, the station bus-bars supplying the remainder of the demand of the feeders, if that is in excess of the dynamo capacity, or receiving the excess from the high-tension dynamo if the demand of the feeders is less. This link takes the form of a booster, having two shunt-wound generators with potentiometer adjustment. If the booster generators are also wound with neutral wire coils, as shown, they compensate for the drop in the neutral, and the station balancer may be a simple one, keeping the voltage of the station end of the neutral midway between the station bus-bar voltages. This, of course, has several advantages.

The following is the method of operation:—

At times of light load the station bus-bars supply the high-tension bars, and therefore the feeders through the boosters, the latter being regulated by the attendant to keep the voltage at the feeding point constant. When the load on the feeders exceeds the capacity of the boosters, a generator is run up to the high voltage required and switched on to the high-tension bars. The attendant

then reduces the voltage of the booster till the generator is taking its full load and the booster supplying very little. If there is not sufficient demand on the feeders to load the dynamo, the attendant reduces the excitation of the boosters, which then feed the station bus-bars, and help the other generators to supply the low-tension demand, or charge the battery if there is one.

By means of the potentiometers the attendant can compensate for any inaccuracy in the neutral coils of the booster, adding to the voltage of one side, and reducing that of the other, and so keep the balance correct at the feeding point.

By this plan only small boosters are required, and economy is gained by the saving in the loss in large boosters, and by being able to keep the generator at, or near, its full load all the time. It is, of course, not truly automatic, as the attendant must attend to the adjustment of the booster potentiometers; but any failure to do so on his part merely affects the proportion of the load taken by the booster, and does not affect the voltage at the feeding-point, which is kept correct by the automatic regulator on the dynamo and by the neutral wire coils on the booster.

When several feeders are fed by the same booster, or generator, the drop in each feeder is affected by the position of the load centre on the network, so it is generally in towns having a fairly equal density of demand that this system can be adopted without much variation of pressure at the various feeding points.

Discussion.

Mr. W. W. Lackie (communicated): With regard to the best arrangement of three-wire feeders and booster in a low-tension system, for some years now it has been agreed generally that networks should not be joined up solid throughout, and in Glasgow each feeder is a three-wire feeder, supplying an isolated piece of network radiating usually in eight directions from each feeding point. Any part of the network can be disconnected from one feeding point and connected to the adjacent feeding point; by this means it is possible to allocate the load on different feeders at times of full load, so as to give fairly equal voltages on all the feeding points. There are other advantages in having each feeder supplying an isolated network. At times of maximum load, when boosting is required on single feeders, the generators are divided up amongst three or four bus-bars, the voltage of the bars varying by about 10 volts from one another. This state of affairs lasts for three or four hours on a winter afternoon only. Another way is to have boosters, either motor or steam-driven, between the different sets of bus-bars, and energy transferred from one bus-bar to another through a booster. A method used in Liverpool was to insert storage batteries to raise or lower the pressure in different feeders.

Mr. Symons (Glasgow) pointed out that Mr. Ker had not mentioned a very useful piece of apparatus which had not some of the disadvantages which the rotary balancer had—the static balancer. With a shunt winding they could guarantee to get a regulation of 1½ per cent. with 15 per cent. out-of-balance current.

Mr. J. A. Robertson (Greenock) said that transmission by three-phase alternating currents to sub-stations with short low-tension feeders, was now the standard practice, and except in very rare instances one would never think of installing feeder boosters to keep constant voltage on the network. The idea of installing boosters at the feeding points was out of the question, and if it was necessary to meet fresh load demands at the end of a long feeder, it would be better to install a battery sub-station than boosters. Mr. Ker seemed to strive too much after automatic regulation of the voltage. He foresaw possibilities of trouble where a number of series boosters were working in parallel from the same bus-bars; in any case, the attendant would be able to control the voltage at the feeding points, and it was not desirable to provide him with too many automatic devices. Shunt or compound-wound boosters appeared to be more suitable than series boosters for the ordinary conditions in central station work. The system described by Mr. Lackie was ideal where they could afford the copper, but even then there must be difficulties about voltage regulation. From the latter point of view the better way was to link up the network through interconnecting fuses, which would automatically disconnect in the event of a heavy short-circuit occurring. He did not believe in series winding on the balancer field. Difficulties in balancing often arose from the balancer being too small, and it was better to use one large steam balancer than two or three small motor-balancers. The static balancer described by Mr. Symons, he believed, was only used at present for direct-current generators driven by three-phase induction motors.

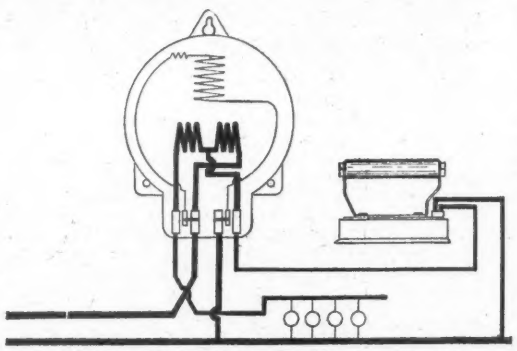
Mr. Robertson (Glasgow) was surprised that the static balancer was not mentioned in the paper.

Mr. Allan (Glasgow) said he could not agree that boosters should be used except in extraordinary cases.

In the course of his reply, Mr. Ker said that his remarks did not apply to large towns like Glasgow. As for static balancers, he believed these only acted by their inaccuracy; if they were accurate they could not balance at all, and Mr. Symons's estimate of 1½ per cent. seemed to him to be rather too good to be true, and was not good enough for the continuous-current rotary balancers. These were, however, of use where they had rough balancing. He condemned hand regulation, arguing that it was better to have something which would regulate itself. A series booster could not go wrong, and its inaccuracy was purely that of construction or design. He thought series winding distinctly tended to improve regulation.

THE "ADNIL" ONE-METER SYSTEM.

The difficulty of supplying electricity at two prices, a higher rate for lighting, and a low rate for power, heating and cooking, due to the necessity of installing two meters, has been ingeniously met by the system introduced by the Adnil Electric Co., Ltd., of Artillery Lane, Bishopsgate Street Without, E.C. A diagram of the connections of the Adnil meter is given below; it will be seen that an extra terminal is provided for the power circuits, which is connected to the main current coils in such a way that the current flowing to these circuits does not pass through all the turns of the main coils, but only a portion of them, the proportion being determined by the ratio of the power to the lighting tariff. The current to the lighting circuits flows through the whole of the coils in the ordinary manner. In the exampled illustrated, the ratio is assumed to be 1 : 2. The rate of the meter, of course, in this case is only half as great for power (or heating) as for lighting, but there is only one set of mechanism, and only one reading on the dial, representing the whole of the units used for lighting, plus half the units used for power. The ratio may be varied in any desired manner. Only one extra wire need be run for the power and heating circuits, a common return being used for all purposes. The system is applied to both the A.C. and D.C. Adnil meters.



Adnil Meter, Type B.E.K. for Combined Power and Lighting Supply.

This extremely simple device should be of great assistance in encouraging the use of heating and cooking appliances and motors for domestic purposes, especially in small houses—a direction in which a vigorous propaganda should be instituted by supply managers, to make up for the reduced revenue on lighting.

"PROTECTION! FROM WHOM?"

[COMMUNICATED.]

It would be hard to find a subject that is being more widely discussed at the present moment by all sections of the public than the vexed topic of "Tariff Reform," "Protection," or "Preference," expressions not having at all the same meaning. The arguments for and against a change in the fiscal policy of Great Britain are hotly debated on every platform nightly, and the impressions gained from a large proportion of those engaged in the engineering industry at any rate, is that Tariff Reform "is worth a trial." Apparently a proposed initial tax of 10 per cent. on manufactured imports is unanimously mentioned and understood, and many electrical engineers consider the erection of a tariff wall the only means of rehabilitating the electrical manufacturing position, which, it cannot be denied, is by no means satisfactory.

The following candid criticism on this subject may express the opinions of many who neither write for the Press nor speak at the Institution. The conclusions drawn are intended to apply only to the results of such a tax on the future of the electrical trade, not on the advisability of Tariff Reform or Preference generally. At the same time, it is the opinion of the writer that such a change in our fiscal system would only benefit a portion of the manufacturers in this country, and possibly their employés, while the remainder and those not so interested (by far the larger portion of the population) would be unlikely to derive any benefit, and conceivably would experience an adverse effect.

The writer cannot for a moment bring himself to believe that the imposition of any such duty, whatever its magnitude, is all that is necessary for the electrical trade in these islands to become immediately or ultimately prosperous. He considers that even if some slight improvement did take place as regards our home trade, it would be counterbalanced by the enhanced price which our manufacturers would doubtless be called upon to pay for manufactured, and partly manufactured, goods purchased from other firms, such as insulating material, wire, slate, &c.

The unvarnished truth of the matter is that the manufacturing side of the business has not been brought to its present languishing

state by foreign competition at all, and it is a debatable point whether the importation of electrical apparatus from America and Germany particularly has not ultimately been to our advantage.

While a great deal of the progress in the application of electricity to industrial and domestic purposes is directly due to the research and invention of English scientists and engineers, it must also be admitted that in many ways we have only followed after having been shown the way. Moreover, owing to grandmotherly and belated legislation and the restrictive effect of vested interests plus the National Conservatism, we have only in recent years taken full advantage of our opportunities. The awakening, unfortunately, coincided with a world-wide period of trade depression, which only now shows signs of lifting.

While, therefore, many reasons can be adduced for our lack of initiative, it cannot be denied that the following epoch-making inventions or improvements emanated from outside these shores. In lighting, the Nernst, tantalum and tungsten lamps and the flame arc lamp. In traction, the multiple unit system of train control and single-phase traction, while we owe the tramway and crane controller, the first really good meter, and the adoption of polyphase supply, to our Continental or trans-Atlantic brethren.

While it may be true that we ultimately adopt and possibly improve on the ideas of other nations, it is also a fact that we seldom initiate and often copy, not only in our own industry, but in others, too, resulting in our taking our place at a competitive stage, and not when the coast is clear of rivals. This is equally so in other trades, notably the automobile industry.

The imposition of a 10 per cent. duty, however, would not have kept out the tremendous number of metal-filament lamps, flame arc lamps, &c., that have been brought into this country in recent years, although it might have diminished the actual sales, to the disadvantage of the trade and the consumer, who most certainly would have paid the tax on these articles, and not the foreigner.

Apart from such articles as those mentioned, the supply of which even now our home manufacturers could hardly deal with, the writer considers that the cry of foreign competition in the electrical trade is greatly exaggerated. Having been closely allied with manufacturing interests for several years, his experience has been that almost invariably the severest competition has been that from English manufacturers. It is questionable if the business being done by alien firms in our industry to-day is obtained entirely on a price basis, and eliminating patented articles and specialities, there will not be found much competitive business. It is notorious, too, that in many articles our foreign competitors are unable to compete in price with our home producers.

Take electric lamps for instance (carbon filament). Not so many years ago an enormous number of German lamps were brought into this country annually. To-day English lamps are produced and sold presumably at a profit at lower prices than those quoted by the front rank of German manufacturers, who have practically retired from this market.

The real trouble in ours, as in other new industries, is that we went too fast in the "boom" days and have been feeling the inevitable reaction. The manufacturing facilities exceed the requirements of our markets, resulting in cut-throat competition in home markets, and loss of vitality in winning and holding those abroad. The lack of standardisation, constant change in design (more often to meet competition than for any other reason) and general lack of cohesion amongst us, account for a great many of the difficulties of the present-day position, and the writer is of opinion that a tariff would accentuate and not remove them.

Protection! I refuse to believe that we require protection from the competition of any outside manufacturer, or that it would be good for our industry to impose a duty such as that suggested.

What we do require is protection from ourselves to prevent us dashing at each others' throats hoping to rise to success over the dead body of our competitors.

The lack of *esprit de corps* and professional etiquette in the electrical industry must be astounding to lookers on in more fortunate callings, while the methods of business of some of even our largest firms, compare sadly with those of successful houses in other trades.

While there has possibly been a general improvement recently, in many respects much still remains before the industry can be considered to be at all on a satisfactory footing. No doubt the position is a difficult one, and the establishment some years ago, by two trans-Atlantic concerns, of large factories in this country (not apparently with successful results in either case) has not made matters easier.

No one could with certainty put his finger on the weak spot, but the writer's hope for the future of our industry, which has played so large a part in the industrial developments of these islands, rest not upon the imposition of a Protective Tariff, but upon "the healing that comes from within." He is of opinion that, despite the difficulties in the way, something in the nature of co-operation between manufacturers is still possible. The training and greater encouragement of the "commercial engineer" is another matter deserving wider consideration, both as regards our home and foreign markets. Again, a more active and wide-awake commercial policy on the part of the Council of our Institutionis surely desirable.

As regards our home trade, a commencement of the co-operative principle might be made by the establishment of a Central Committee representative of the principal manufacturers. The object of such a board would be to decide, amongst other things, what firms should receive trade terms. A financial status bureau could be added, and while responsible firms would not suffer, much might be done to weed out and discourage the undesirables in our midst.

As regards foreign markets co-operation could surely be of assistance, especially in the case of the smaller firms, particularly in the direction of the preparation and dissemination of catalogues suitable for the market for which they are intended.

The addition of a central co-operative purchasing department, and workmen's registration bureau, is surely not incapable of realisation.

It is well known that co-operation in the direction of price-fixing has not up to the present been found possible, but short of this much might be done in the direction indicated, and in the adoption of standard conditions of sale and maintenance of selling prices to the trade and the public upon certain standard articles.

There are many other ways in which such a co-operative body could act with advantage to the whole industry.

The writer does not desire for one moment to pose as a detractor of English enterprise to the advantage of foreign competitors. He has great hopes for the future of our industry, but "hope deferred maketh the heart sick," and many of us have already felt the effect of continual discouragement and non-success.

The time has come for taking stock of the position and arresting the downward course, and I believe much can be done on the lines mentioned.

Protection would be worse than useless, the medicine required is not for outward application, but, however nauseous, must be swallowed.

OUR LEGAL QUERY COLUMN.

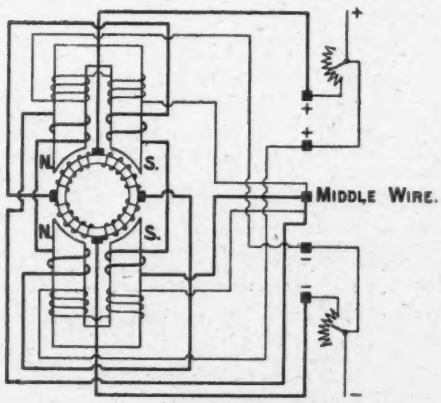
[*Questions addressed to this column should be written on one side of the paper only.*]

"F. S." writes:—"I shall be glad if you will kindly let me know (1) whether, under the Electric Lighting Acts, undertakers for the supply of electricity have power to make and enforce wiring rules. I should also be glad if you would kindly let me know (2) whether it is possible for undertakers, in the event of laying a service into premises where the supply is not eventually used, to legally demand the cost of the service."

*** As to (1), by virtue of Sec. 6 (*c*) of the Electric Lighting Act, 1882, undertakers have power to make by-laws "for securing the safety of the public from personal injury, or from fire or otherwise." Down to 1903 no by-laws had ever been made and sanctioned under this section. Where local authorities are themselves the undertakers, Parliament has in recent years repeatedly given to them special power to make such by-laws, but it has not often been exercised. As to (2), unless the contract provides for a minimum payment for each year, the undertakers are without remedy if the consumer chooses to take no current at all during the year. They would have no legal claim for the cost of the service.

THE "C.M.B." BALANCER.

IN July last we described the single-armature single-commutator motor-generator styled "The C.M.B. Patent Auto-Converter," which was introduced by Messrs. Crompton & Co., Ltd. Amongst the many applications then mentioned was its use as a balancer for three-wire systems, for which purpose it is eminently suitable. The machine is perfectly automatic in its action, and maintains equal voltage on either side of a system under all conditions of load distribution. Compared with other types of balancer it shows



1381

CONNECTIONS OF C.M.B. BALANCER.

to great advantage in its high efficiency and close regulation, its simplicity of construction, the small weight and floor space required, the small wear and tear on the brushes, there being only one commutator, and the ball bearings.

The accompanying diagram shows the method of connection when used as a balancer. The armature is divided into two equal parts

by the short-circuited brushes; the polar limbs are all equal in dimensions; the series compounding coils are arranged on all the poles—not only for the purpose of voltage regulation, but also for balancing the circulating current across the short-circuited brushes.

Its success when applied to balancing three-wire circuits is seen in two machines which have been supplied to the Calcutta Electric Supply Corporation. They deal with an out-of-balance load of 60 KW. on either side of the middle wire, the voltage of the outers varying from 460-530 volts.

These machines balance the voltage within 1 per cent. of the mean value on either side of the middle wire at all voltages between 460 and 530. Their through efficiency, when converting the full out-of-balance current, was 94 per cent., a figure much higher than that which can be obtained with the ordinary two-machine sets.

A C.M.B. balancer has recently been installed by Crompton and Co. at the Stoke Newington Borough Council's sub-station, Edwards Lane, Church Street. The machine was designed to deal with an out-of-balance current of 100 amperes in the middle wire of a three-wire system, with a pressure of 480-530 volts across the outers. It was specified to maintain equal voltage on either side of the system to within 1 per cent. without any adjustment of the regulator, and to run sparklessly at all loads up to 25 per cent. overload.

The following readings, taken simultaneously by three different persons at the official tests on site, are of interest:—

Out-of-balance current.		Volts.	
Pos.	Neg.	Pos.	Neg.
—	100	242	242
—	125	240	242
—	50	246	244
Balance.		250	247
50	—	242	240
100	—	248	245
120	—	248	245

Throughout the test the field rheostat was not touched—that is to say, the regulation was entirely automatic. The through efficiency when converting the full out-of-balance current was 90 per cent., and the machine ran quite sparklessly throughout, even under the 25 per cent. overload. Messrs. Talbot & Stevenson, the consulting engineers on the job, considered the machine "highly successful."

Among other notable instances of the application of the C.M.B. may be mentioned the case of the Kilmarnock Corporation, where a machine has recently been installed dealing with an out-of-balance current of 100 amperes in the middle wire on a 480-volt three-wire system; and the Consett Iron Co., to whom a C.M.B. machine, working as an auto-converter, has recently been supplied, with an output of 200 amperes at 250 volts, and an input at 500 volts.

LEGAL.

National Lighting Corporation, Ltd., *v.* Tess, Ltd.

In the City of London Court on Thursday last week, before Mr. Registrar Wild, a claim was made by plaintiffs, of Saracen House, Cock Lane, Snow Hill, against defendants, of 4, Hanover Square, for £2 1s. 6d., for 13 200-volt electric lamps supplied. The plaintiffs' claim was admitted, subject to an allowance being made for electric lamps which turned out to be inferior and damaged soon after being used.

Margaret McKenzie, in the employment of the defendants, gave evidence, and said that the lamps which were now produced in Court, were part of those supplied by the plaintiffs, and placed in her charge. Some of the lamps burned for an hour, and some for a day, and then were of no further use, because they would not light at all. She had brought to the Court six of the lamps, and none of them would give a light.

The Secretary of the defendant company said he had tried some of the lamps. He had had one placed in the room occupied by himself. The lamp burned for an hour, and then went out. In another case he knew of a lamp being placed in the holder, but it gave no light. They had complained to the plaintiffs that the lamps were not what they should have been. Cross-examined, he did not know what was the matter with the lamps. They simply went out. They had been handled carefully. He knew if the lamps were roughly handled that the filaments would be liable to break.

For the plaintiffs it was said that the lamps were in good condition when delivered to the defendants. They were tested before being sent out.

In answer to the Registrar the plaintiffs' witness said the lamps were partly made in Holland, but were obtained by him from London representatives. They were supposed to burn 1,000 to 2,000 hours. The first complaint received from the defendants was six weeks after delivery. Their collector had made several calls for payment of the account, and after the sixth call it was said that the lamps were faulty. It was the custom in the trade for lamps to be tested upon delivery. There was a statement upon their invoice that all complaints were to be made within three days. The lamps delivered to the defendants should have been tested before their man left the premises.

Mr. Registrar Wild said he thought, after hearing the evidence, that the lamps had been tested by the defendants within a reasonable time, and found defective. He found for the defendants for the difference claimed.

Judgment was entered for the defendants beyond the money paid into the Court. An allowance of 15s 6d. was made for expenses of witnesses.

Bournemouth and Poole Electricity Supply Co. *v.* T. O. Barrett.

At the Bournemouth County Court recently, plaintiffs sued the defendant, a builder, of Southbourne, for £5 16s. 3d. damages for breach of contract.

The plaintiffs' case (according to a local newspaper) was that the defendant entered into an agreement with them to take a supply of current if the electric light was connected with and installed in his house in Paisley Road, undertaking that after this expense had been incurred he would not use any other method of lighting, and that the fittings should only be removed by the company's officials. The connection from the company's main was made at a cost of £3, and 15 fittings were supplied, at a cost of £2 16s. 3d., but although this had been done the current had never been used, and the defendant had not given the company notice to remove the fittings. Defendant admitted signing the agreement produced, but said he was not certain it was signed in respect to the house in question. He also admitted that the main was laid to the house, but contended that this was done at the company's own risk, while with regard to the fittings he said they were supplied by Messrs. Fudge & Co., of Boscombe, and not by the company. Gas, and not electric light, he said, was used in the house.

Mr. Turner, for the plaintiffs, explained that the fittings were put in the house by Messrs. Fudge on behalf of the company.

Defendant said there were no fittings in the house other than those he was charged for by Fudge's.

His Honour adjourned the case for further evidence, and, when the case was resumed, Mr. Turner said he would amend the part of the claim relating to fittings to £1 17s. 6d. He called Mr. F. Moody, manager at Fudge's, Boscombe, who said his firm supplied ten fittings to defendant's house on the written order of the Electricity Supply Co., who paid the bill to the firm.

In reply to the Judge, Witness said it was not true that defendant was paying Mr. Fudge for the fittings.

His Honour gave judgment for the plaintiffs for the amount of the amended claim, £4 17s. 6d., being £3 for connecting with the main and £1 17s. 6d. for the fittings.

New St. Helens Tramway Co., Ltd., *v.* St. Helens Corporation.

In the Chancery Court of Lancashire, held at Liverpool on January 11th, before Vice-Chancellor Leigh Clare, Mr. Courthope Wilson applied on behalf of the plaintiffs for an injunction to restrain the defendants from disconnecting the overhead electrical equipment providing electrical power for the tramways of the two concerns at Haydock and at Prescot. The St. Helens Co. run through traffic, and for general convenience the overhead wire was connected at the Prescot end in 1902; in October last, at the request of the plaintiffs, the St. Helens Corporation made a similar connection at Haydock. In consequence of the St. Helens Co. using cars of the South Lancashire Tramways Co. over the Corporation lines the latter threatened to disconnect the overhead wire at both ends. While this would not prevent the St. Helens Co. from running through traffic, it would leave an awkward break in the overhead equipment, necessitating changing the trolley from one wire to another. This would cause delay and inconvenience, and in consequence of the darkness during the changing at night, grave risk to the public would ensue.

Mr. Lawrence appeared for the Corporation, and, according to a report in a Liverpool paper, contended that his clients were acting strictly within their rights; the tramway company had been given no right to the use of the Corporation electrical equipment, although they had been granted rights over the tramlines.

The Vice-Chancellor suggested, after hearing legal arguments, that the question had better be left over until the trial of the action, which he would do his best to expedite.

Mr. Lawrence agreed to this, the understanding being that things should remain as they were pending the trial.

His Honour: Very well. It seems to me a case of Tweedledum and Tweedledee. At the trial I will decide who is to have the rattle.

German Enterprise in Italy.—A company has just been formed at Milan under the title of the Società Anonima Forza, with a share capital of £100,000, in which German firms are interested, for the establishment of electricity works. The board of directors includes the names of Theodor v. Guilleaume, Max v. Guilleaume, Walther von Rath, Louis Hagen, Arthur Heiliger, Karl Steven and Prof. Bernhard Salomon.

HEAT TRANSMISSION AND FUEL ECONOMY.

By P. J. PRINGLE.

It is undoubtedly a fact that the problems surrounding the subject of heat transmission in boilers are to-day in many quarters but little understood, and the importance of them with regard to boiler efficiency is seldom appreciated.

The majority of up-to-date electricity supply stations do realise that the presence of scale greatly reduces boiler efficiency, and have met this difficulty by the installation of water-softening plant.

I think it will be readily conceded that the treatment of feed water inside the boilers, either chemically or mechanically, for the purpose of throwing down the solids, is but a makeshift compared with the treating of the water in a separate water-softening plant.

In the Electrical Review for October 22nd, 1909, a leading article deals with the subject of heat transmission, and refers to the valuable paper recently read by Prof. W. E. Dalby dealing with this matter. His paper should greatly assist in the better understanding of the problems surrounding the question of boiler efficiency.

The question of efficient heat transmission, where it has received serious consideration, has generally been viewed from the water side of the boiler.

Some of the figures given in the paper are startling, and should force the still large proportion of boiler users who do not make any serious attempt to keep scale out of their boilers, to review their position. In the undertaking with which I am associated, the feed water has a hardness varying from 24° to 28°, and four years ago a Harris-Anderson water softening plant of 4,000 gals. per hour capacity was installed. This plant reduces the hardness to an average of 6° to 8°, at a cost of 2·19d. per 1,000 gals.

There is no doubt that the reduced cost of boiler maintenance, together with the fuel economies effected, owing to the improved heat transmission, has allowed the expenditure on the softening plant to be wiped off after the first three or four years. In my town, I believe that our plant is the only one in operation, although the hardness of Burton water is notorious, ranging anything from 24° to 40°. This alone shows there is very much to be done in this direction, and I have no doubt that similar conditions exist elsewhere.

From a series of experiments we have been making, I am of the strong opinion that the question of efficient heat transmission has an aspect just as important and possibly more so, on the fire or flue side of the boiler as on the water side, and some particulars as to what we have done in this direction will no doubt be of interest to other undertakings.

I will first describe how we were led up to the importance of the subject just named. A Krell CO_2 recorder was installed two years ago, and regular tests of the flue temperatures instituted. The percentage of CO_2 on first installing the recorder was found to average in the main flue about 4 per cent., the minimum at times being as low as 2—3 per cent. and the maximum never exceeding 5 per cent. By careful attention to air leakages, thickness of fire, adjustment of draught and more intelligent stoking, we improved gradually until the average percentage of CO_2 in the main flue increased to 8 per cent. with a minimum of 4 per cent. and a maximum of 10 per cent. In the boiler flues the results when first installing the CO_2 recorder averaged 6 per cent.; they now average 11 per cent.

Undoubtedly some useful savings in fuel were effected, but I was still far from satisfied with the boiler-house efficiency. Every other direction which could lead to better efficiency was then reviewed. In overhauling a boiler it is the general custom to do little more than hard brush down the furnace or water tubes, and the shell of the boiler in contact with the furnace and flues. This only frees any serious collection of soot or soft carbonised deposit. My chief assistant, Mr. Thomas Hall, who has shown great interest in all the experiments we have made, then suggested that the usual cleaning down of the tubes and outside shell of our Lancashire boilers should be carried much further than we had been in the habit of doing. Our boiler plant consists of three 26 ft. × 8 ft. and three 26 ft. × 8 ft. 6 in. Lancashire boilers, the maximum number under steam being five.

On February 27th, 1909, one boiler was dealt with in the following manner. The whole surface of the fire side of the tubes, and that portion of the shell in contact with the side and middle flues, was scraped down with hard steel scrapers so as to get to the metal surface. We found that the deposit on the tubes was of a hard ashy nature varying in thickness from $\frac{1}{32}$ in. to $\frac{1}{8}$ in., and that the deposit, as it got towards the cooler parts of the flue, became of a more tough and pitchy nature, and that this deposit also varied in depth from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. These deposits do not include the flocculent, sooty deposits, which bring up the thickness to as much as $\frac{3}{8}$ in. in some parts.

The fuel we burn is, generally speaking, of a low grade. Three varieties are in use, of varying price and calorific value, the lowest averaging 7,700 B.TH.U., and the highest 11,500 B.TH.U. I do not know that there is anything special about these fuels to make the deposit excep-

SCHEDULE.

Month.	No. of weeks.	Units sold.		Pounds of fuel per unit sold.		Cost of fuel per unit sold.		Cost of fuel in £.		Saving due to more economical working, in £.
		1908.	1909.	1908.	1909.	1908.	1909.	1908. A	1909. B	C
						d.	d.			
January	5	138,949	140,056	15·3	13·7	·394	·378	228 5	220·9	—
February *	4	106,680	109,936	14·9	14·2	·393	·385	174·7	176·2	—
March †	4	100,914	100,831	15·3	13·3	·406	·349	171·1	146·7	11·9
April ‡	5	111,895	114,277	15·6	12·0	·44	·292	205·4	139·2	45·1
May	4	87,078	84,807	15·9	14·0	·465	·324	169·0	113·3	35 8
June	4	104,094	100,136	14 2	11·95	·381	·274	165·1	114·5	28 7
July	5	152,908	147,270	12·5	11·5	·346	·264	240·7	162 6	31 3
August	4	139,035	118,686	11·2	10 5	·316	255	183 5	125·9	33·1
September	5	178 861	178,266	11 9	9 75	·309	·230	229·8	171·2	48·2
October	3	111,655	118,868	11·4	9 55	·324	·238	150·9	116·9	17·3
Totals (8 months) and averages	—	986,440	963,141	13 2	11·4	·364	·272	1,495·5	1,090·3	251·4

Notes.

* February 27th.—First boiler scraped and in service.

† Second boiler scraped and put into service at the beginning of first week; third boiler by the beginning of third week.

‡ Fourth boiler scraped and put into service at the beginning of second week.

Since April 1st, 1909, reductions in price of coal were obtained; the difference between columns "C" and "A" minus "B" represents the amounts due to these reductions.

The proportions of the different grades of fuel vary a good deal, and this accounts for some of the variations in figures shown from month to month. For the first four months of 1908, January to April, the fuel costs were slightly increased, due to a condenser being shut down.

tional, and I have no doubt that the scale conditions on the fire side of boilers follow on these lines in the majority of cases.

The scraping of the tubes and shell of one boiler had a most marked effect upon the fuel consumption. We then proceeded at once to treat all the working boilers in a similar manner, and the figures in the schedule on the previous page indicate the results that were obtained.

The January and February figures are given, these being previous to the scraping process, so that the marked effect of the same can be readily seen.

In viewing the lb. of fuel per unit sold, and the cost of fuel in pence per unit, the following facts should be taken into consideration :—

The average calorific value of the fuel consumed in 1908 from March onwards was 10,200 B.TH.U., and 1909, 9,980 B.TH.U. The price of fuel is a low one, and for the former period averaged 5s. 1½d. per ton, and for the latter 4s. 6d. The generating station is some 14 years old, and much of the plant is not of a very efficient nature. The supply is high-tension-alternating for lighting and power, so that there are the average stand-by losses inherent in such a system.

The traction supply is at 500 volts without the use of a battery, and the load factor a low one—20 per cent. These conditions, it will be seen, do not tend to low fuel costs. All the engines with the exception of one, which is only used occasionally, have the advantage of running condensing.

As indicated above, the average cost of fuel for the 1908 figures was 5s. 1½d. per ton, and in 1909 4s. 6d. per ton. The same three classes of fuel were used for both periods, but in April, 1909, lower quotations were obtained for these. If during the 1909 figures we had worked under the same boiler conditions as in 1908, we should have burnt the same relative proportions of each grade of fuel, and these reductions would have brought the average price down to 4s. 7½d. per ton, or a reduction of 6d. We found, however, after the scraping process, that the improvement in the boiler efficiency permitted a rearrangement of the three grades of fuel in use, so that a larger proportion of the cheaper grade fuels could be burnt with satisfactory results. Therefore, the difference in the price per ton between the 1909 and the 1908 figures, viz., 7½d., less the 6d. referred to above, can quite fairly be directly credited to the scraping process.

The figures for lb. of fuel per unit sold show in themselves a very marked reduction since the scraping process : the saving averaged 13·6 per cent. As a lower-grade fuel was used in 1909, the percentage saving is obviously still greater than this. Under the station conditions mentioned above, and with the low grade of fuel in use, the figures obtained during the last few months, of 10 lb. of fuel per unit sold, are of a distinctly satisfactory nature. The load factor of supply will be about 20 per cent. for the year.

The effect of the scraping process on the four boilers, which has only been in use for 7½ months of the 8 months shown, can be summarised as follows :—

Allowance must be made for fewer units sold in 1909. These represent 23,351, and a fair fuel price for these additional units would be ·2d., representing £19·5.

The net saving in fuel is therefore the £251·4 shown in the schedule, less £19·5—that is, £231·9, or 15·5 per cent. ; and the lb. of fuel per unit sold have been reduced from 13·2 to 11·4, or 13·6 per cent., notwithstanding that the average calorific value was reduced from 10,200 to 9,980 B.TH.U. The amount of fuel saved was nearly 900 tons.

The cost of the boiler-scraping process is but a small item, and amounts to 15s. per boiler. We do this at periods of two months, which means after six to seven weeks' service. The saving due to the reduced tonnage of fuel unloaded and handled and the disposal of ashes nearly balances the cost of scraping.

At the end of each service period the hard deposit is less than half what it was before the scraping process was first put into operation. On the hotter parts of the tubes there is very little deposit. In the cooler parts of the flue there is still a good deal of the flocculent, sooty deposit.

There is no doubt that if means could be taken to regularly clean the surfaces, in a similar manner to that in use with economisers, it would result in an important increase in boiler efficiency.

Tests on the flue temperatures show that the conditions have been improved in a very marked manner by the scraping process. The main-flue temperatures previous to entering the economiser have been reduced about 70°, and the temperatures on the other side of the economiser about 50°. The temperature of the gases going to the stack averages 370° F. The temperature of the feed-water on entering the economisers averages 100° F., and on leaving 265° F.

I anticipate that our fuel costs per unit, including unloading and disposal of ashes, will, on our present year's returns, be reduced to about ·28d. per unit. In most undertakings the boiler house will be found to offer the best field for the introduction of economies, and I hope that these few notes giving the results of our experience will induce still further investigations.

The above experiments have been carried out with Lancashire boilers ; it would be interesting to know to what extent a similar treatment would improve the efficiency of boilers of the water-tube and other types.

BUSINESS NOTES.

"Simplex" Meter Department.—Messrs. Simplex Conduits, Ltd., have issued a catalogue, in a striking cover, of their electricity meters, ammeters and voltmeters, which, we understand, are now being submitted to the Board of Trade for approval while they are used by some of the largest electricity supply departments throughout the country. The meter department, which the firm established some months ago at 116, Charing Cross Road, W.C., has been rapidly and satisfactorily developed. In it they have laid down an extensive plant for carrying out complete tests on all types of electricity meters and for the calibrating thereof. Every meter is tested before being sent out, in addition to being calibrated at the works. A special set of converting machinery is installed for changing the ordinary supply to give any

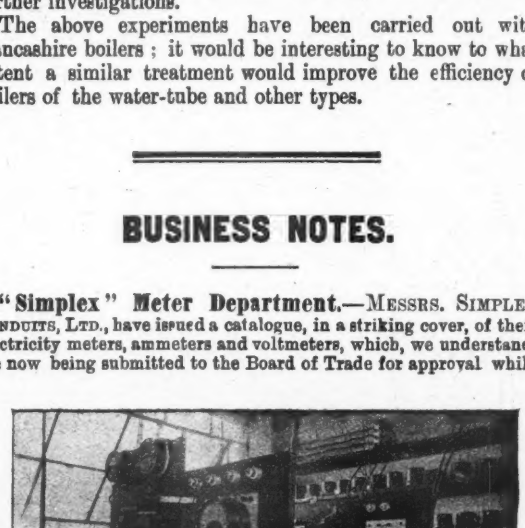


Fig. 1.—"Simplex" Test Benches.

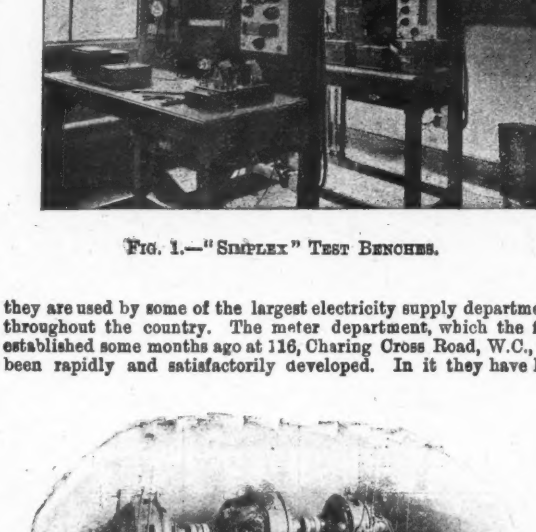


Fig. 2.—Converter Plant at "Simplex" Meter Department.

phase displacement and frequency and all voltages up to 600. Considerable stocks of the most used types of meters are carried. Fig. 1 shows a view of the test benches; fig. 2 represents the set installed in the machine room. The list of meters gives full particulars of accuracy curves for each type, with dimensions, weight, and full diagrams for connecting. In the case of alternating type meters, separate diagrams are given for single, two and three-phase currents. Considerable data are also included on the testing for accuracy of Simplex meters. These data are compiled for when tests are conducted in the laboratory and also *in situ*; for the latter, however, a convenient form of check meter can also be supplied, if desired, suitable for continuous, alternating and polyphase meters. The catalogue is neatly arranged, and prices are clearly set out.

Rubber.—The progress of this trade throughout the year is traced by MESSRS. S. FIGGIS & Co. in their annual review. The price was very much stiffened during 1909. Last January good sheet could be obtained for 5s. 3d. By October it had reached 9s. 1½d., and closed, after fresh supplies, at 7s. 3d. to 7s. 5d. The higher prices of the autumn are attributed to motor-car orders, as well as activity of the "bear" speculators, who then found themselves obliged to cover.

Messrs. Figgis note an improvement in quality, and urge the desirability of "standardising" the various grades of rubber. The estates might ship three qualities—No. 1, pale; No. 2, light brown and grey; No 3, dark and brown—and note the advantage held by "smoked" sheet during the rush.

The world's supply is given as 69,000 tons for 1909, against 65,000 tons in 1908, and 69,000 in 1907. The consumption is estimated at about 68,000 tons, which does not seem a large margin. Of yielding plantations, Malaysia appears to be next in importance to Brazil, then Ceylon, Dutch East Indies, India and Burmah (a long drop), Borneo, New Guinea and the West Coast of Africa.

Trade has been good in England and France, middling in Germany and Russia, and unprecedentedly large in America.

The Bradford Electrical Engineering Co., Ltd. (in Liquidation).—Mr. J. Herbert Haley, incorporated accountant, of Bradford, writes as follows, under date January 8th:—

"My attention has been drawn to a letter written by Mr. C. J. Cassé, and published in your issue of the 31st ult., containing grave misrepresentations which may seriously affect my position, and it is, therefore, my duty to contradict the same, and to ask you to be good enough to place the following facts before your readers:—

"1. Your report of what took place at the statutory meeting of creditors is substantially correct.

"2. Mr. Charles John Cassé and Mr. Harry Herbert Cassé were the vendors to the company, and are described in the contract of sale and purchase to the company as having traded together in *co partnership* under the style or firm of the Bradford Electrical Engineering Co. Moreover, on the outside of their shop window the name appeared as C. J. Cassé & Son; a picture of this I have in my possession.

"3. According to a prospectus issued (copy of which I have), they originally asked £1,200 for their business, including an item of £700 for goodwill. They ultimately agreed to accept £566 7s. 7d. for it, and to take £450 of the purchase money in ordinary shares and £116 7s. 7d. in cash, the item of goodwill being eliminated. Seeing that the investigation of the accounts had not been made by me, they agreed in the contract with the company to guarantee the debts and credits to be as stated in their accountants' balance-sheet, and the amount of £341 referred to as owing by the vendors arises by reason of such guarantee having been given. I was not appointed to investigate the accountants' balance-sheet and accounts, as Mr. Cassé well knows, and I received my instructions from their solicitor, who confirms this in the enclosed letter (see next column). The whole object of the guarantee was to protect any variation that could arise in the figures. The shareholders who have lost their money also fully understood the accounts had not been examined by me, and have exonerated me from any blame.

"4 The books of the old firm were badly kept, and at December 31st, 1907, two months after the incorporation of the company, a fresh stock-taking was made, and I prepared the accounts in detail, with the result that the vendors, under their contract, were liable to repay the sum of £341. This item was made up as follows:—

Liabilities to June 30th, 1907	£510	6	5
Amount stated in balance-sheet at that date	231	18	6
Liabilities understated	£288	7	11
Nine private liabilities of the vendors paid between July 30th, 1907, and October 28th, 1907	34	9	0
Cash unexplained at December 31st, 1907 ...	9	2	4
Book debts adjustment account	9	13	0
	£341	12	3

"Mr. Cassé was thereupon given every opportunity to examine and explain the discrepancy in the figures, as correspondence shows, and a special report was made by me to the shareholders. Prior to the holding of the statutory meeting, Mr. Cassé wrote me the following letter, the original of which is fastened in the company's minute book:—

"'*January 30th*, 1908.

'To Mr. J. Herbert Haley,

'Dear Sir,—I have been much exercised about the incorrectness of the balance-sheet drawn up for me by a firm of Bradford accountants, upon whose expert skill I have relied. I am extremely sorry that I am unable to return the sum in cash, as practically my all was invested in my business. After considering the matter from every standpoint as to how I can put myself right with my fellow directors and shareholders, as nearly as my means will allow me, I offer to sell at the earliest opportunity £200 shares and place the proceeds to the credit of the company, holding the remaining £141 shares as a loan from the shareholders at the rate of 5 per cent. per annum interest. Or I would be willing to hold the shares allotted to me and guarantee to all the present shareholders a dividend of not less than 10 per cent. per annum on shares now held by them. I am sure I could do this if I get the loyal support of my fellow directors and shareholders generally.

'I leave it to you to put this matter of my proposal before the shareholders, and trust that one of them will meet with their approval.—I am, yours truly,

'(Signed) C. J. CASSE.'

"This letter was put before the shareholders at the statutory meeting of the company held on January 30th, 1908, and the support Mr. Cassé asked for was given, and the following was the resolution passed:—

"That in respect to the sum of £341 12s. 3d. due by the vendors, this sum be loaned to them at the rate of 5 per cent. per annum, Messrs. Cassé to sign a promissory note for the amount payable on demand, and deposit with the auditor (on behalf of the company) shares in the company for £350, as security for the amount; Messrs. Cassé are to be at liberty at any time to redeem the loan, or any portion thereof, in the meantime all dividends on these shares to be taken by the company in reduction of the said loan.

"Both the Messrs. Cassé were present at the meeting, and the company's solicitor (who was also their solicitor) was instructed to prepare a contract incorporating the terms. This was done, Messrs. Cassé admitting the £341, as having been examined and found correct by them, and this contract is filed at Somerset House.

"5. I am sorry a slight inaccuracy occurred in my statement as to the profits, as I have been desirous, throughout this matter, to be fair and just to all parties. The profit and loss accounts are as follows:—

June 30th, 1908.—Profit after providing preliminary expenses ...	£183	0	2			
June 30th, 1909.—Loss...				£88	13	3
Sept. 30th, 1909.—Loss (3 months) ...				281	7	8

"The loss shown in the last account caused me to think there was a mistake in the stock, with a result that an independent valuer was called in who valued the same on the basis of a going concern at £316 13s. 4d., and who stated the previous stock was overvalued. Messrs. Cassé had signed the following certificate in reference to their September 30th, 1909, stocktaking:—

"'We hereby certify that the stock-in-trade has been taken and valued by us at the above date; that the amounts of such stock are correctly stated as follows:—Stock-in-trade, £694 3s.; work in progress, £51; total, £745 3s.; and that the same has been taken at cost or market value, whichever was the lower at the date named.

'Dated October 7th, 1909,

'(Signed) C. J. CASSE, H. H. CASSE } Managing directors.'

"6. As regards the statement of Messrs. Cassé, it is false to say that the two directors resigned their position on November 18th last. I have never said this, and I have been incorrectly reported. The dates of the resignations are:—C. J. Cassé, October 15th, 1909; H. H. Cassé, November 4th, 1909; and the termination of their services dates from October 31st, 1909.

"7. My salary with the company, £63 per annum. I acted at the special desire of the shareholders, being appointed at the annual meeting to keep the books with a view to saving a clerk's salary, and that is why the fee was fixed at the figure named. It has not paid me at the amount. Seeing that Mr. C. J. Cassé moved, and Mr. H. H. Cassé seconded, my appointment at the last meeting, I fail to see what object they have in referring to this matter in their letter.

"I am sorry to ask for so much of your space, but under the circumstances I feel sure you will grant it, and thanking you in anticipation, I am,

"J. HERBERT HALEY, *Incorporated Accountant*."

Re THE BRADFORD ELECTRICAL ENGINEERING CO., LTD.

36, Sunbridge Road, Bradford,
January 6th, 1910.

Dear Sir,—Referring to my interview with you this morning, I beg to confirm what I then stated, viz., that you were *not* instructed to investigate the accounts of the vendors, and that as a previous investigation had been made I did not consider it necessary to go over the same work again.—Yours faithfully,

W. I. CRABTREE.

J. Herbert Haley, Esq., Incorporated Accountant,
Bradford.

For Sale.—The Oldham Corporation Electricity Committee is offering for sale a number of Lancashire boilers, Willans-Hall and Willans-Siemens direct-coupled sets, condensing plant, pumps, piping, switchboards, &c. Some particulars appear among our advertisements to-day.

Warning to Electrical Traders.—We are given to understand that a firm of merchants in the East Central District of the City is giving out fairly large orders and inquiries for certain lines of electrical and other material, and is calling for samples. It is recommended that before entering into definite business relations with them electrical firms should make close investigations. This is all we can say at the moment.

Bankruptcy Proceedings.—SAMUEL EMERSON SMITH, electrical engineer, 271, High Street, Lincoln.—The adjourned public examination of this debtor was held last week at the Sessions House, Lincoln. The case had been adjourned for the debtor to render a cash account, giving all the receipts and payments for three months prior to the realisation being made, and also to furnish the Official Receiver within 14 days with all invoices, receipts and carbon copies of all letters or orders received for goods. The Official Receiver complained that the debtor had not complied with the order, and said it was not until after he had written him on January 5th last that the debtor sent in a most unsatisfactory account in pencil, very carelessly done, and he had not sent in the invoices at all. After debtor had been asked some questions by the Registrar, the Official Receiver applied for an adjournment *sine die*, and said the case was one in which he felt he must report to the Board of Trade. The Registrar, however, said he would give the debtor one more chance. He would again adjourn the case, debtor to comply with the order of the Court within 14 days.

WILLIAM LESLIE, electrical engineer, formerly of Putney, now of H.M. Prison, Brixton.—The last day for sending proofs for intended dividend to Mr. H. W. Figg, the trustee, 128A, Queen Victoria Street, E.C., is January 18th.

ROBERT EDWIN WALKER, Eign Road, and 16, Widemarsh Street, Hereford, electrical engineer, &c.—The first meeting of creditors herein was held last week at 2, Offa Street, Hereford. The statement of affairs showed liabilities amounting to £200, all due to unsecured creditors, and assets £181, leaving a deficiency of £19. The debtor claims that he was solvent at the date of the partnership, and states that his present position has arisen through complications in consequence of entering into a partnership which prevented him from paying his own debts, whilst at the same time his partnership and other assets were sufficient. The matter was left with the Official Receiver.

PETER SMITH, electrician, 18, Mill Street, Warrington. — A receiving order was made on January 7th on the debtor's own petition.

Calendars and Catalogues.—MESSRS. ALFRED GRAHAM & Co., St. Andrew's Works, Crofton Park, S.E.—We have received from this firm a desk blotting pad with useful diary, interleaved with blotting, at the left-hand side. The gilt lettering will keep the firm's patent "Navyphones" and other loud-speaking naval telephones well in the mind of the user of this pad during 1910.

MR. E. C. AMOS, 3, Laurence Pountney Hill, London, E.C.—Pamphlet relating to the "Winterthur" Diesel engines as made by the Swiss Locomotive and Machine Works, Winterthur. Copies of this pamphlet, also of the firm's gas engine and producer catalogue, can be obtained on application.

THE ELECTRIC CONSTRUCTION CO., LTD., Dashwood House, 9, New Broad Street, E.C.—New pamphet (20 pages) containing a description, with a number of finely-executed half-tone illustrations, of the "Simplex" bar coal-cutting machines (Peake and English patents). All engineers concerned with the application of electricity in collieries would be interested in this publication.

MESSRS. CLASSEN & Co., G.m.b.H., Barbarossastr. 16, Berlin, W. 30.—"Fludor" diary for 1910, illustrated with the career of a youth to whom Fludor brought dignity and prosperity. Copies may be had on application to the firm.

MESSRS. T. REYNOLDS & Co., LTD., of High Street, Coventry, have issued a picture postcard, quite up to date in interest, showing, as it does, Mr. Asquith and Mr. Balfour seated discussing the various good points of the "Auriga" metal-filament lamps, which give "light on both sides."

THE USKSIDE ENGINEERING AND RIVET CO., LTD., Uskside Iron Works, Newport, Mon.—Hanging wall calendar with neat monthly tear-off slips. Two small half-tone views show some of their mining machinery—a standard type portable electric haulage, and a high lift ram pump. Copies can be obtained on application.

MESSRS. MAVOR & COULSON, LTD., 47, Broad Street, Mile End, Glasgow.—Calendar for 1910 with large monthly sheets with boldly printed dates. A view appears of a D.C. coal-cutting machine mounted and adjusted for undercutting.

MESSRS. MERRYWEATHER & SONS, LTD., London.—A striking and effective wall calendar, the pictures and general design of which will keep us all from forgetting—even were we at all likely to do so—the great ability and reputation of the firm as manufacturers of motor fire apparatus and all fire appliances and escapes.

THE TUDOR ACCUMULATOR CO., LTD., 119, Victoria Street, S.W.—Pamphlet describing the T.A.C. system of electric train lighting. The dynamo used is of the differential compound type, driven from the axle, and having a very flat characteristic. An automatic switch is provided, and a single battery, to the terminals of which the lamps are directly connected. To maintain constant pressure on the lamps, they are run in series with special iron-wire resistances, which absorb the fluctuations of pressure, the variation at the lamps being within 4 per cent.; the method involves the use of two additional cells, but avoids the use of a mechanical regulator. When the cells are fully charged, an "overcharge switch" comes into action and prevents further charging. The system is in use on many foreign railways, and on the North British railway.

MR. G. WUTHRICH, Oswaldestre House, Norfolk Street, London, W.C.—Eight-page pamphlet containing a reprint from a contemporary of an article describing, and stating the advantages claimed for, the Oerlikon variable-speed three-phase motors in the driving of textile machinery. Copies may be obtained on application.

MESSRS. E.M.F., LTD., 10, Ironmonger Lane, London, E.C.—Advance leaflet (R) containing illustrations, and a note of prices, of a number of designs of "E.M.F." luminous and convector radiators.

MESSRS. SIEMENS BROS. DYNAMO WORKS, LTD., Caxton House, Westminster.—Typed list (six pages) of lantern slides showing a great variety of Siemens manufactures, ranging from small supplies to complete electrical installations. Additions have been made to the list since it was last issued in February, 1909. The slides are primarily intended for the use of lecturers, to whom they are loaned free of charge by the firm.

With the compliments of "The Efesca Electrical Works," we have received a wall or table calendar for the current year. A block of weekly date slips is in the left-hand bottom corner of a card which bears in colour the picture of our old familiar friend, now a sure reminder of Efesca lamps. Each day's date appears in the centre of a print of the "Efesca" lamp. MESSRS. FALK, STADELMANN & Co., LTD, of Farringdon Road, will send a copy to any electrical contractor or dealer.

THE GAUMONT CO., LTD., 5 and 6, Sherwood Street, Piccadilly Circus, W.—Pamphlet describing the Gaumont continuous-current "Arconomiser" transformer, and arc lamps and other electrical materials for cinematograph and other purposes.

MESSRS. GASSER ET CIE., Basle.—Pocket diary for 1910.

MESSRS. HUGHES & STIRLING, 7, Arundel Street, London, W.C.—Publication giving particulars of a test by Dr. J. A. Purves, the consulting engineer, on, and illustrations of, the "Sterling" back-fed regenerative refuse destructor erected for the Paignton Electric Light and Power Co., Ltd.

From the BRITISH WESTINGHOUSE CO. we have received a wall calendar with monthly slips, by the sides of which are reminders of "Auriga" metal-filament lamps and "Arcturus" arc lamps. An interesting picture of the impressionist stamp appears above the slips, but we do not think it has any direct application in connection with the electrical industry.

SIEMENS BROS. DYNAMO WORKS, LTD.—Large postal card giving a view of their London stores and showroom at 39, Upper Thames Street, E.C., and a street map showing how they may be reached.

MESSRS. WELLMAN-SEAVER & HEAD, LTD., 47, Victoria Street, S.W.—Owing to our notice of their playing-card souvenirs last week, Messrs. Wellman-Seaver & Head inform us that they "have been inundated with a perfect hail of requests for them," and ask us to state that the demand has completely exhausted their stock.

MESSRS. EVERETT, EDGCUMBE & Co., LTD., 87, Victoria Street, London, S.W.—Calendar for 1910, consisting of 12 monthly tear-off sheets. On either side of the month's dates there are given original sketches by Mr. John Hassall and views of the firm's electrical instrument manufactures.

FOSTER ARC LAMP AND ENGINEERING CO., LTD., Worple Road, Wimbledon.—Leaflet relating to their metal-filament lamps, which are entirely British made, as the manufacture is carried out from start to finish in their works at Wimbledon. Owing to rapid increase of business, the company have taken a temporary factory while their new works are being built. An output of about two millions of metal-filament lamps per annum is anticipated. Copies of the list will be sent to any interested reader.

MESSRS. LUDW. LOEWE & CO., LTD., Farringdon Road, E.C.—Pamphlet G, which we have received from this firm, deals especially with "Loewe" automatics, comprising pin and stud and screw machines, also with the firm's turret lathes for repetition or other work of larger size which does not lend itself to automatic production. The pin and stud machine is made in six sizes, and the screw machine in five sizes, and both types of machine can be provided with an automatic screw-making attachment. The usefulness of this class of tool is well known; diagrams showing the great variety and quantity of work turned out by the different models are included in the pamphlet.

WESTERN ELECTRIC CO, North Woolwich.—New Bulletin (No. 4,002), 28 pages, just issued, is a "preliminary list" of Western Electric telephone instruments, bell circuit telephone installations, central battery telephones, automatic intercommunication telephones (new metal-key type), automatic replacement type, magneto telephones, portable telephones, and a variety of accessories.

BRUSH ELECTRICAL ENGINEERING CO., LTD., Loughborough.—A small pocket folder giving prices of "Metallum" lamps for voltages from 100 to 135 and 200 to 250 and for candle-powers ranging from 16 to 100. The makers represent theirs as "the final improvement" in metal-filament lamps.

MESSRS. J. P. HALL & CO., LTD., Blackriding Ironworks, Werneth, Oldham.—New and revised price list of totally enclosed D.A. type reversing crane motors. In the course of 16 pages it gives descriptive and general specification, with tabulated horse-powers, speeds, weights, and prices, of motors for 110, 220, 440 and 500-volt windings. Ventilated enclosed motors and electrically-operated magnetic brakes are also particularised. A good deal of new information appears. The firm will be pleased to send a copy of the catalogue to any firm interested in electric drives where the load is intermittent and the duty severe, such as on capstans, winches, punching, drilling and boring machines, rolls, saws, planers, &c.

MESSRS. JENS ORTEN-BÖVING & Co., 9½, Union Court, Old Broad Street, London, E.C.—Eight-page pamphlet relating to the flexible insulating couplings of the Zodel-Voith patent and B.B. type, which are made in England. Sizes, weights, code-words and prices are given, also a list of a number of users. A loose list gives details of the Reich flexible insulating coupling.

Italy.—La Società Anonima Forza is the title of a new company, which has just been formed in Milan, under German auspices, with a capital of £100,000.

(*Continued on page* 64.)

ELECTRICAL HAULAGE INSTALLATION at the LOFTUS IRONSTONE MINES.

An interesting example of the adoption of electricity for haulage purposes is represented in an installation which has just recently been put into service at Messrs. Pease and Partners' ironstone mines at Loftus-in-Cleveland. Although Messrs. Pease & Partners are large colliery proprietors, the question of the saving in fuel consumption at the Loftus ironstone mines is of prime importance as the distance from the South Durham coalfield to the Cleveland ironstone area is considerable.

As will be seen in the plan (fig. 9), this mine consists of two drifts running into the face of the hillside to the east of the valley separating Loftus and Carlin How.

Nothing in the way of electrification has yet been attempted at the northern drift, as the ironstone is easily brought to the inbye end of the main haulage plane, from which sets of 10 tubs at a time are pulled out to the surface by a steam-driven hauling engine. The other drift, extending in a south-easterly direction, is also operated by means of a steam hauling engine at the surface, and it serves to bring stone from three different districts, namely, White Cliffe Mine, which is underneath a part of the township of Loftus; Loftus Mine proper, which is further to the north; and also Grinkle Mine, some two miles distant.

The problem to be solved in the adaptation of electricity to the underground haulage was so to place the hauling engines that the lead of the ropes should be as straight as possible, and also to arrange so that either engine could relieve the other in the case of breakdown or stoppage from any cause.

It will be seen from fig. 9, that the inbye haulage roads meet at the bottom of the drift from the surface, and that at this point the ropes from the two haulage gears cross.

Owing to the intermittent nature of the load on these haulages, it was decided to take the supply from the Cleveland and Durham Electric Power, Ltd., whose sub-station is situated at the mine.

For the endless rope haulage at White Cliffe, the centrifugal pumps, drainage pumps, and the electric drills at the face, the lighting at the surface and underground, and for motors of various sizes on the surface, energy is obtained from a private generating station, which is equipped with three four-cylinder vertical Campbell gas engines. Each of these engines is coupled direct to a continuous-current generator having an output of 230 KW., the voltage being normally 550.

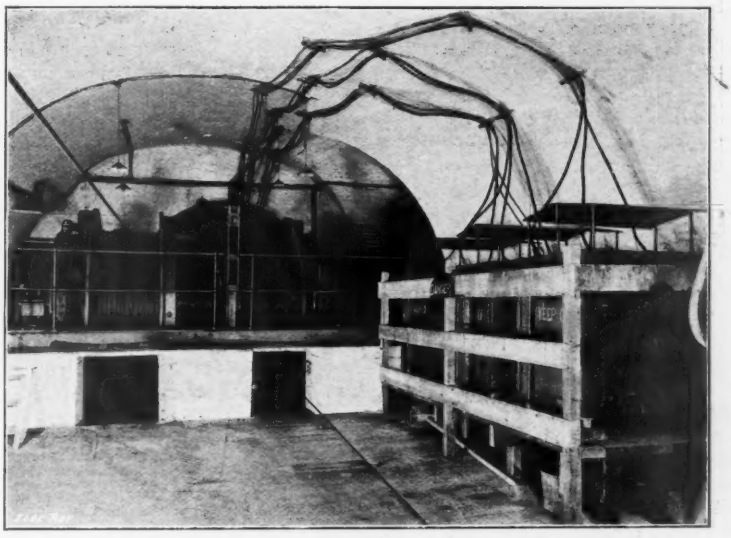


FIG. 1.—300-H.P. ELECTRICAL HAULAGE GEAR, No. 4 HAULAGE ROOM.

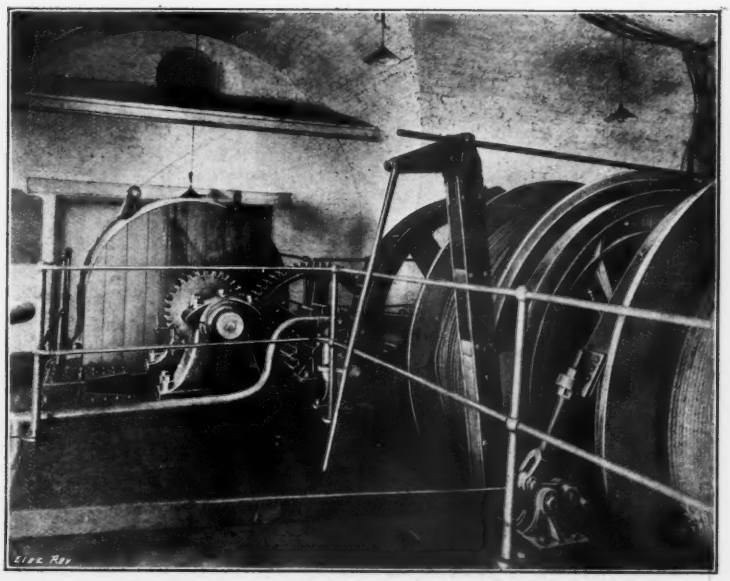


FIG. 2.—DRIVING PLATFORM, No. 4 HAULAGE, SHOWING PUMP FOR WATER CIRCULATION

A supply of gas is obtained from three suction-type producers, also made and supplied by the Campbell Gas Engine Co., and fired with Durham coke breeze obtained from Messrs. Pease & Partners' own collieries.

In the power house is the distributing switchboard for the various circuits in the mine and on the surface to which continuous current is supplied, and in another corner is placed the high-tension switchboard to which the Cleveland and Durham Power Co.'s cables from the transformer station are led. On this board is mounted a recording wattmeter and the leakage indicators in accordance with the Home Office regulations.

Taking first the use to which the high-tension current is put, we follow down the drift the three-core cable of ·15 sq. in. area, which is laid solid under the travelling road.

At the junction marked on the plan, the cables are led to a distribution board, and from this point smaller cables, ·075 sq. in. area, are led on to the No. 5 haulage room. This haulage gear was originally worked by a horizontal steam engine, the bed-plate of which still remains, and may be seen in the foreground of fig. 5. Subsequently, for more than two years, it was driven by a continuous-current motor supplied from the gas engine power station, and in many respects this proved a satisfactory arrangement.

The motor was of Scott & Mountain's manufacture, of 250 H.P., running at a normal speed of 375 R.P.M., and

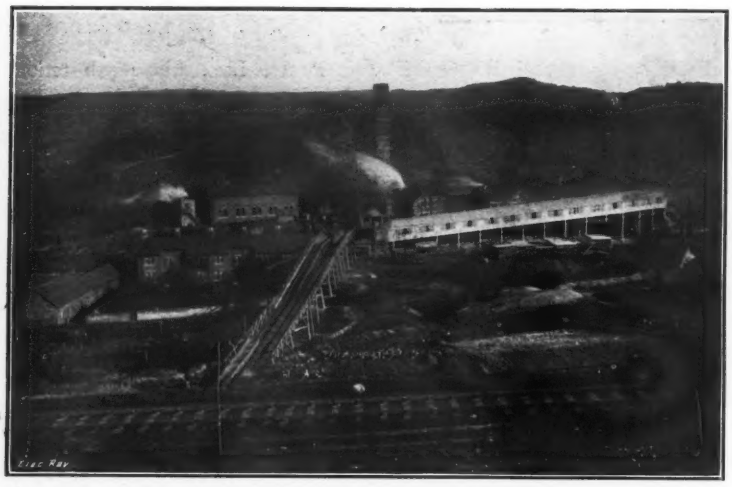


FIG. 3.—VIEW OF THE LOFTUS MINES FROM THE WEST.

was regulated by means of a metallic controller of the tramway type with iron grid resistances. The only difficulty was due to the unavoidably intermittent nature of the load which occasionally caused irregular working in the power station, and had the unfortunate result of bringing down the voltage over the whole system every time the gear was started up.

In view of this difficulty and the steady increase in number of constant running machines underground and on the surface which provided sufficient load for the power station, it was decided to replace the motor by one of the three-phase type supplied from the power company's mains. The motor now in use was constructed to deal not only with its normal load, but also with the work ordinarily done by the No. 4 haulage. It is of 250 to 300 H.P., running at a speed of 460 R.P.M., and wound for a pressure of 2,750 volts and 40 cycles.

The position of this motor in the haulage room driving on to the intermediate shaft through cotton ropes is seen in fig. 5 and behind the motor, in a specially constructed archway, is fixed the controller, which is a very massive apparatus specially designed for this work and having several interesting features.

The controller is divided into three sections, *i.e.*, one for each phase, each with 15 steps, and each step in the controller consists of a quick-break switch with positive action, and, in addition, a spring break arranged so that in the event of the spring failing, the switch will continue to be effective.

Each step is connected by insulated cable to resistances carried in three galvanised iron tanks situated close to the controller. These tanks, one for each phase, are each oil filled and fitted with heavy copper circulating pipes, through which cooling water is forced by means of a centrifugal pump driven from the shaft of the motor. The controller body is mounted upon heavy cast-iron supports, and is raised clear of the ground, and so arranged that the oil-filled tanks in which the switches operate can be readily lowered to provide for inspection and renewals.

The controller is worked by means of a hand-wheel fixed at the end of a long steel shaft carried up to the operating platform. On the pedestal carrying this hand-wheel is also fixed the reversing switch, which is interlocked with the main wheel so that the connections cannot be reversed until the wheel is in the "off" position. The reversing switch itself, which is oil-filled, is placed below this pillar under the floor of the operating platform.

Still further back in the archway behind the motor are water resistance tanks to supplement the metallic resistances

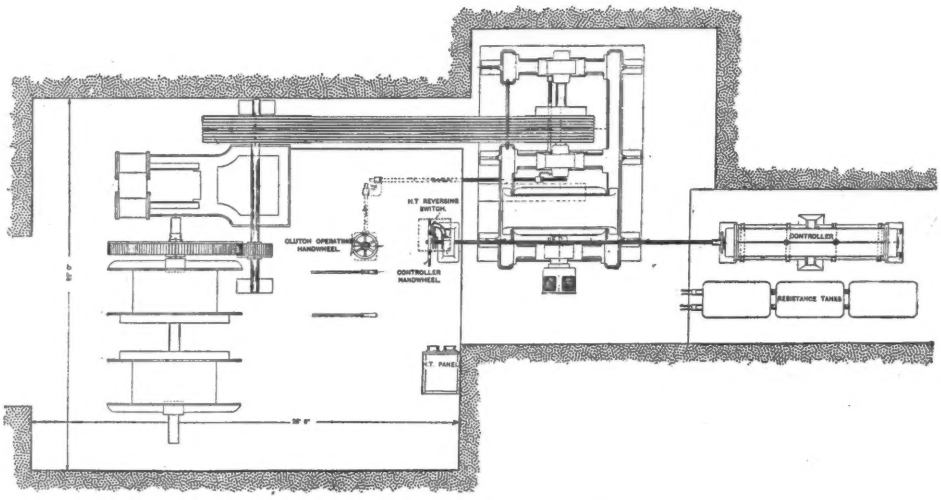


FIG 4.—PLAN SHOWING ARRANGEMENT OF NO. 5 HAULAGE PLANT.

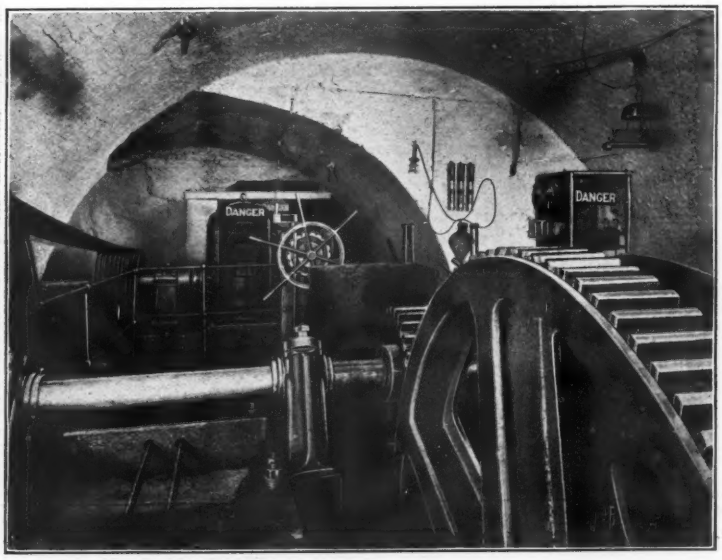


FIG. 5.—SHOWING MOTOR, SWITCHGEAR, &C., NO. 5 HAULAGE ROOM.

already described. These water tanks are constructed of elm planks, 1½ in. thick, and they each have a capacity of

approximately 190 gallons; they are used to absorb a very large proportion of the energy at starting, so as to

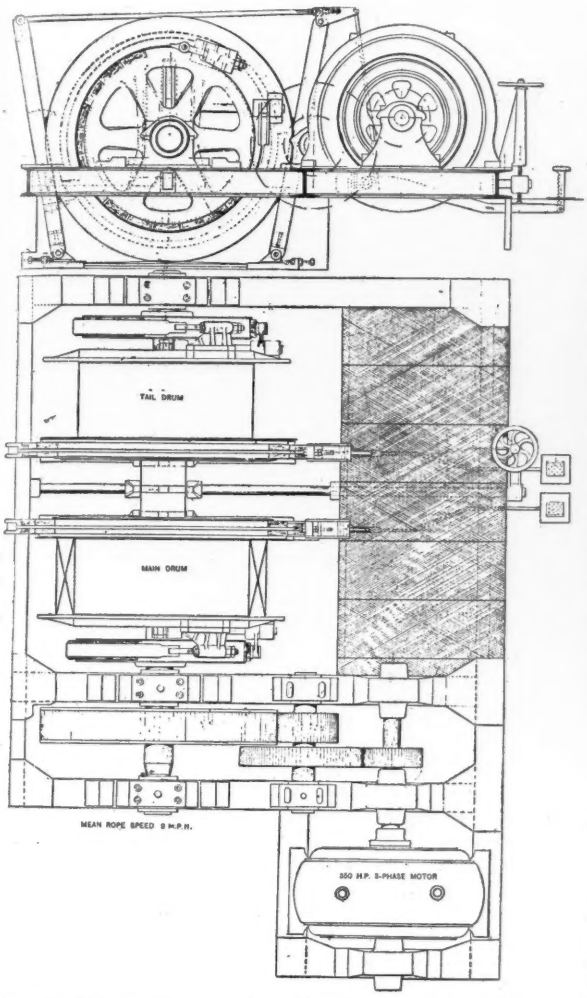


FIG. 6.—300-H.P. MAIN AND TAIL ELECTRICAL HAULAGE GEAR, No. 4 HAULAGE ROOM.

give a very gradual acceleration when picking up a set of tubs.

These liquid resistances are coupled to the first three steps of the controller, and are then relieved of further work, any regulation beyond this point being carried out by the water-cooled metallic resistances. A steady speed of from 1 to 2 miles per hour can be maintained with the liquid resistances in circuit, for purposes of adjusting the length of the rope, or for allowing the slack between tubs to be taken up gently.

Behind the switches and tanks is placed a water receiver for the cooling of the metallic controller, from which 3 in. steel pipes are led to the centrifugal pump previously referred to.

In one corner of the haulage room and within clear sight of the operator, is fixed the high-tension switches with automatic overload and no voltage trip coils, and also a voltmeter and ammeter.

FIG. 7.—PORTABLE TRUNK PUMP AND MOTOR ON BOGIE AT WHITE CLIFFE.

The work performed by this haulage consists of bringing sets of from 30 to 50 tubs at one time over the somewhat uneven road from Loftus or Grinkle. In the latter case the run is 2,500 yards in length, and occupies from start to finish, approximately 10½ minutes, giving an average speed of 8¼ miles per hour.

The motor is fully capable of running the set at a higher speed by the substitution of a larger pulley should this at any time be found desirable. At the junction of the White Cliffe and Loftus roads has been installed the new 300-H.P. haulage room, views of which are given in figs. 1 and 2.

As the main switchboard, controller, resistances, and water tanks on this gear are practically the same as at No. 5, they do not merit further description, but reference may be made to the haulage gear itself, which is of exceptionally powerful and massive design.

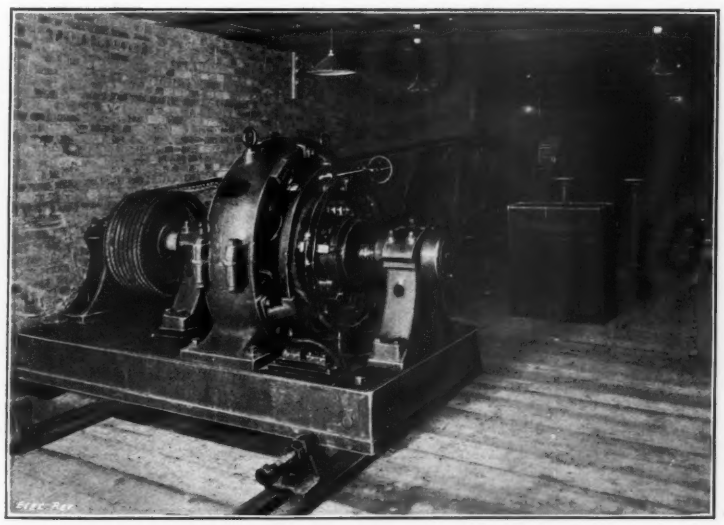


FIG. 8.—ENDLESS ROPE HAULAGE GEAR, WITH ROPE DRIVE.

There are two drums, each 6 ft. diameter, on the barrel, and 2 ft. 8 in. wide, the shield boards being 8 ft. 6 in. diameter overall. This gear operates the district known as White Cliffe, where a very large quantity of stone remains to be won, and, in order to provide for all likely future requirements, it has been arranged to run at the somewhat high speed of 9 miles per hour, which involves a speed on the drum shaft of 40 R.P.M.

The whole of the drum sides, clutch centres, spur wheel, &c., are made in halves, and, with the assistance of the eye bolts secured in the roof of the haulage room, they can be readily taken to pieces or moved when required. Each of the two drums is fitted with a Hall type friction clutch consisting of a very heavy cast-iron centre keyed to the main shaft and revolving with it.

Outside this centre is an all-round brake strap 6 in. wide fitted with elm blocks and operated by means of rods and levers inside the haulage drum and connected to a sliding sleeve between the drums.

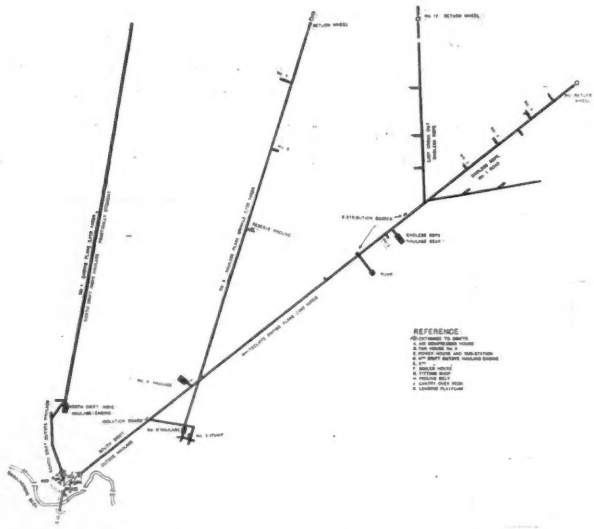


FIG. 9.—ELECTRICAL HAULAGE SCHEME, MESSRS. PEASE & PARTNERS' LOFTUS IRONSTONE MINES.

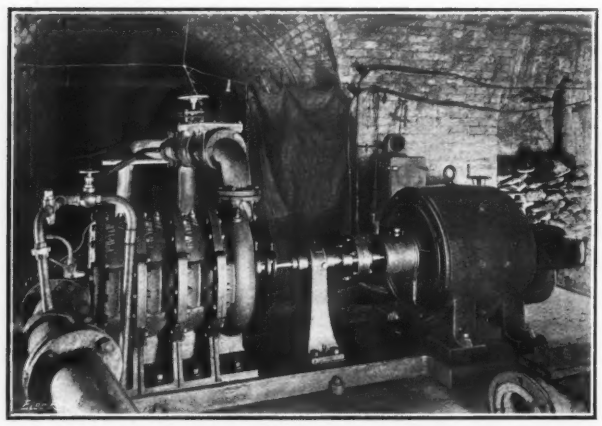


FIG. 10.—CENTRIFUGAL PUMPING PLANT IN No. 5 ROOM.

The position of this sleeve is regulated by means of a hand wheel with double shrouded screw, and is arranged so that either drum may be put into motion or stopped at will. Any wear that may take place upon the brake blocks or driving centres is readily taken up by right and left-hand screws at the end of the straps and inside the body of the rope drums.

The driving wheel upon the main shaft is of cast-iron, with machine-moulded teeth, fully shrouded, and in turn it is driven by a forged-steel machine-cut pinion, mounted on a short intermediate shaft, which also carries the large cast-steel machine-cut spur-wheel on which the first speed reduction is made. Gearing into this wheel is a solid forged machine-cut pinion mounted on an extension of the motor shaft and carried between two independent bearings.

To this shaft, by means of a half-coupling, is secured the rotor shaft of the motor. This machine is capable of giving up to 450 H.P., and runs at a normal speed of 325 R.P.M., the supply pressure being 2,750 volts. Owing to the frequent starting and stopping which is required from this machine, it is fitted with a wound rotor with very massive slip rings, which are fixed outside the end bearing and are protected by means of a sheet-iron cover. The slip-rings are of gun-metal, 3 in. wide, and are each fitted with three carbon brushes carried in box-type brush-holders.

The whole of the gear and the motor are mounted on steel framework of H section, strengthened under all the bearings with cast-iron blocks securely bolted in position. Underneath the motor is the cast-iron box containing liquid starting resistances, this accessory having proved advantageous owing to the very frequent switching on and off to which the motor is subjected, and also because it derives its power from such a large network of mains throughout the Tees-side and Durham County. A similar device is also fitted to the motor at No. 5.

In connection with the direct current installation, there are fixed on the surface, motors for operating the picking belt, tippler and small motor-generator for providing the lighting current for arc and incandescent lamps. The 60-H.P. belt motor is started and stopped by an "Esco" liquid switch under the control of a man placed at the top end of the belt, the motor running at 350 R.P.M., and driving on to the reduction gear of the picking belt through a heavy canvas belt 19 in. wide.

The inbye cables are led down the same drift as the high-tension circuit, and comprise two pairs of single cable, each consisting of 37 wires, 13 S.W.G., insulated with vulcanised bitumen and braided and compounded overall. These cables are led through to the distribution board at White Cliffe, a total distance of 1,561 yards, junction boxes being fitted at various points *en route* where branch cables are connected.

Tappings from these cables are taken off for the lights in No. 5 haulage room, No. 4 haulage room and the sidings at the junction of the roads from White Cliffe and Loftus Mines.

The continuous-current distribution board consists of a heavy cast-iron casing mounted on brick pillars, and carrying heavy double-pole switches mounted on a slate base. The circuits on the board are five in number, and provide for the centrifugal pump room adjoining, the endless rope haulage some 200 yards further inbye, the drainage pumps placed at

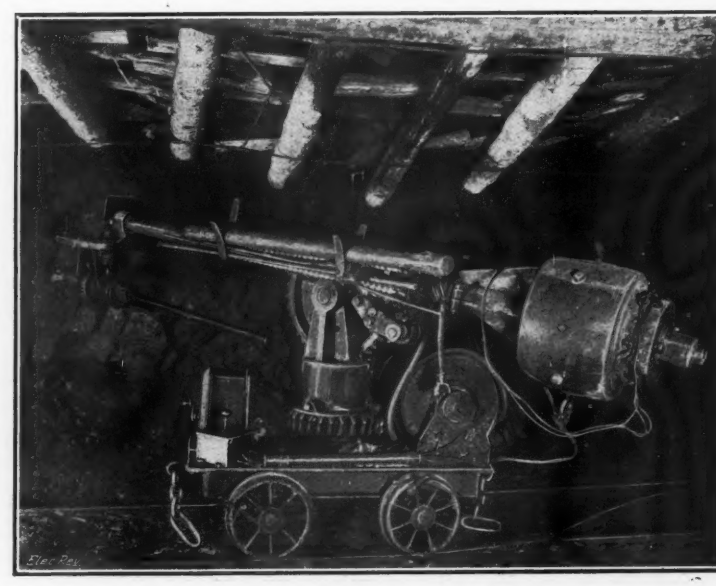


FIG. 11.—5-H.P. MOTOR DRIVING ROCK DRILL.

various points nearer the face, and the electric drills, which are in turn run from separate circuits leading out of special distribution rooms at the side of the travelling road.

The two centrifugal pumps are of Gwynne's manufacture, and they have been constructed to deliver 600 gallons per minute, against a head of 300 ft., and the motors driving them are each of 85 H.P.

The pumps are worked alternately, and deliver the water to the surface, and the mine is fortunate in having large standage accommodation, which enables the pumps to be worked economically under the present strict regulations as to hours. Each pump set, one of which is shown in fig. 10, is provided with a switch column consisting of a double-pole switch with circuit-breaker and ammeter, the whole being ironclad and fireproof. The motors are started by means of "Esco" liquid switches.

The endless rope haulage gear operates two roads leading inbye to the face and brings the tubs out to the assembling points, where they are picked up by the No. 4 main rope haulage. The haulage gear itself consists of two rope wheels, each 6 ft. diameter, arranged to run at a speed of 7 R.P.M., which gives an approximate speed on the rope of 1½ miles per hour. These wheels and the clutch centres to which they are secured are made in halves, as is also the large spur-wheel on the main shaft.

The clutches for starting and operating the rope wheels are of the Hall type, as already described at No. 4 gear, but in this instance a separate operating lever and hand-wheel is provided for each wheel, so that the two may be run simultaneously if desired. All-round strap brakes are provided to both wheels. There is a double reduction upon the haulage gear itself, this being rendered necessary by the very slow speed of the main shaft. A further reduction from the motor is effected by means of eight ropes, each 1½ in. diameter.

The motor is of Scott & Mountain's standard type, with three bearings and independent pulley shaft. It is constructed to develop 100 H.P. continuously, and is intermittently capable of giving up to 150 H.P., its normal speed being 525 revolutions. The motor is started and stopped by means of an "Esco" liquid switch, which is clearly seen in the view (fig. 8).

The drainage pumps, which are of the ram type, deliver their water to the sump, which supplies the two centrifugals already referred to. These drainage pumps, one of which is shown in position in fig. 7, are of the portable type with direct-geared motors, and are of two sizes, one suitable for 50 gallons per minute, and the other for 90 gallons.

As will be seen from the illustrations, the switchgear for the motors is also mounted on the pump framework, so that the whole set is readily removed as circumstance requires.

At the face of the mine, useful work is done by a large number of electric drills, which, on account of the hard nature of this Cleveland ironstone, are of very massive design. The drills are each capable of boring 30 holes of 1½ in. diameter and 3 ft. to 4 ft. long in one hour, and carry a separate supply of trailing cable on a special drum fitted with sliding contacts, the starting switch and regulator being also fitted on the drill carriage (fig. 11).

The whole of this installation was designed by Ernest Scott & Mountain, Ltd., of the Close Works, Gateshead-on-Tyne, and carried out by them, under the general direction of Mr. W. Moore, the manager, and Messrs. T. Scott and W. Robson, the mechanical and electrical engineers respectively at the Loftus Mines.

Gateshead.—At a meeting of the T.C. on the 5th inst., the Town Improvement Committee reported the receipt of a letter from the Gateshead and District Tramways Co., containing a proposal that the fares on the Wrekenton branch should in future be divided into farthing stages, with a minimum of 1d. The only increase of fare would be that a passenger travelling from Wellington Street to Sheriff Hill would be charged 1½d., instead of 1d. as at present. The Committee recommended the Council to approve of the company's proposal, subject to its termination, at any time hereafter, by either company or corporation on the expiration of one month's notice. The town clerk pointed out that the company had no power to increase the charge of 1d. made on workmen's cars.

SUCTION GAS PRODUCER PLANT.

A CONSIDERABLE amount of controversy, not always of the wisest sort, has from time to time been raised as to the suitability of suction and pressure gas plant for power purposes. It is not altogether clear that any definite or useful results were obtained by these discussions, although they undoubtedly added interest to life at the time. Perhaps the chief defect which they had was that rather too much attention was given to theory and not quite enough to the actual details of producer practice. Without sufficient data to argue upon, it is impossible, in any case, to come to a definite decision, and for this reason a few points with regard to producer plant practice may be of interest, even if unaccompanied by any theoretical deductions, to those who closely followed these discussions.

Although producer plants are quite capable of doing good and useful work, there is no doubt that they have their little troubles in just the same way as any other power plant, and on some occasions these defects bring in their train a certain amount of inconvenience. For example, in one suction-gas plant, the failure of the vaporiser produced a very big rise in temperature of the furnace, which resulted in the melting of the fire bars and the formation of big clinkers. In a short time the furnace became completely choked, and the plant had to be shut down. When the vaporiser came to be examined, the defect was trivial, and was very quickly put right, and the plant was able to resume work. It is, however, useful to remember that there appears to exist a need, even at the present time, for a vaporiser for such plants, more thoroughly reliable at all times than some of the devices which are at present on the market.

Another trouble which has given the producer plant a worse reputation than it deserves, is due to faulty operation in the following way:—Too much steam may, in the first place, be allowed to mix with the air before admission to the producer. The temperature inside the producer drops in consequence, with the result that a higher proportion of CO_2 is present than is necessary. This, of course, causes the calorific value of the gas to fall, and the engine, therefore, develops less power than it should. Considerable trouble may be caused in this way owing to the neglect of a very simple adjustment.

One of the indictments which have been brought against gas producers is that in pressure types, at any rate, there is a serious danger of poisonous gases being forced through the producer into the air surrounding it, and there is no doubt that more than one attendant on such plant has suffered through being gassed in this way. Even in pressure plants, however, liability to such trouble could be very largely overcome by the very simple precaution of inserting a water seal between the producer itself, and the gas holder which regulates the pressure. The working pressure should not exceed 4 to 5 lb. per sq. in., and the control of a moderate pressure such as this is quite a simple matter.

It may fairly be argued that a good many of the troubles which have attended the operation of electric supply plants, both large and small, driven by producer plant, have been due in a considerably greater degree to lack of foresight as to working conditions in the lay-out of the plant than to any inherent defect of the producer itself. In a producer plant of considerable magnitude, it was arranged that as the engines were too large to be started by hand, they should be operated by means of compressed air until they had attained normal speed and firing. The compressed-air tank was filled by means of a motor-driven air compressor, the motor of which was supplied from the main electric supply from the dynamo. Under ordinary conditions this arrangement was calculated to work quite well, but upon one occasion the filling of the air tank before shutting down the main engine was omitted, with the result that when the next run was required there was no means of restarting the engine. The amount of trouble that was experienced in this connection brought consideration to bear upon the problem of what would occur, should by any chance a leak occur either in the air tank or in the system of pressure piping, over a long-continued period of rest, with the result that in order to cope with emergencies of this sort, a small engine with an independent gas supply was installed to work the air com-

pressor. This is an instance of trouble which undoubtedly interfered with the normal working of the supply of electricity, but which could not be attributed to any defect in the producer itself.

A cognate instance can be mentioned involving the question whether the motors used for the fans, tar scrubbers, and gas-cleaning plant, and for any auxiliary apparatus, should be operated from the main electricity supply. Where there are several separate and distinct producers and gas-driven units comprised in the plant, there is not such a very great danger of a total breakdown as would be the case if the whole of the supply depended upon one main unit, but it is a serious point for consideration in plants of this description whether it is not advisable either to drive such auxiliary plant directly from separate steam engines or an entirely independent gas plant, or alternatively to have a small gas plant installed, in order to run a separate electrical system for the purpose of station supply, which would include not only the auxiliary motors, but also the station lighting, and, where alternating current was used, the field excitation of the generators.

BUSINESS NOTES.

(*Continued from page 58.*)

Book Notices.—*The Practical Electrician's Pocket-Book and Diary*, 1910. Edited by H. T. Crewe. London: S. Rentell & Co. Price 1s.—The regularity with which this little book appears at this season shows that familiarity with it does not breed contempt on the part of those who use it; the repeated trials to which we have subjected its contents justify their approbation, and the variety of the matters touched upon, in a lucid and interesting manner, tempts one to prolong unduly the examination of its pages. The diary is the least interesting section, though this, like the text, has been revised and brought up to date, as usual. Amongst the new features are the Siemens O S. wiring system, auto-transformers and instructions to chargemen.

The Electrical Engineer's Diary, 1910.—Messrs. S. Davis and Co, 30 and 31, St. Swithin's Lane, E C., have sent us a copy of this diary, identical with that which we noticed last week under the heading, "Accumulator Industries, Ltd." Messrs. Davis & Co. are the publishers and proprietors of the diary, which is published at 2s. 6d., and readers who desire copies should apply to them direct. The contents of this useful production were reviewed in the note above mentioned, under "Calendars and Catalogues."

In the *Model Engineer and Electrician* for January 6th there commences an article by Mr. A. W. Marshall describing the construction of a 500-watt dynamo, specially designed for the purpose of lighting with metallic-filament lamps at 25 volts. A coloured plate is given, showing the details to scale, and the design is intended for the use of the amateur equipped with a fair outfit of tools.

"The Linear Resistance between Parallel Conducting Cylinders in a Medium of Uniform Conductivity." By A. E. Kennelly. (Reprint from *Proceedings*, American Philosophical Society, Vol. XLVIII, 1909.)

"The Equivalent Circuits of Composite Lines in the Steady State." By A. E. Kennelly. (*Proceedings* of the American Academy of Arts and Sciences, Vol. XLV, No. 3.)

"A Contribution to the Statistics of International Electrical Engineering Symbology." By A. E. Kennelly. (Reprinted from the *Electrical World*, August 12th, 1909.)

The *Journal* of the Röntgen Society, which has hitherto appeared bi-monthly during the working session of the Society only, will in future appear quarterly, commencing with the current month.

"Physical Society *Proceedings*." Vol. XXI, Part VI. London: Taylor & Francis. 1909.

"Electrical Engineer's Pocket-Book, 1910." "Mechanical Engineer's Pocket-Book, 1910." Edited by W. H. Fowler. Manchester: Scientific Publishing Co. Prices, cloth, 1s. 6d. net; leather, 2s. 6d.

"Bulletin of the Massachusetts Institute of Technology"; Catalogue, December, 1909. Massachusetts: The Institute.

"Patents" (British and Foreign). By A. A. Thornton. London: C. Jones, Ltd. 1910. Price 21s. net.

Trade Announcements.—Mr. Arthur P. Haslam, M.I.E.E., has commenced business and opened an office at Suffolk House, Laurence Pountney Hill, Cannon Street, E C., where he is prepared to act as representative for two or three manufacturers of electrical or engineering specialities. We have known Mr. Haslam for many years, and are sure that his experience and other qualifications will fit him for efficiently representing some manufacturers who are on the look-out for a London representative.

Messrs. J. H. Taylor & Co., electrical engineers, have opened new showrooms in Macaulay Street, Huddersfield.

An Australian exchange says that "Messrs F. E. Bradford, electrical engineer, and G. W. Gilbert, directors of the Woods-Gilbert Rail Planer Co, were passengers for London by the R.M.S. *Otranto*. It is their intention to bring this local invention before railway and tramway companies."

Messrs. T. Harding, Churton & Co., of Atlas Works, Leeds, have appointed Mr. B. T Dale, of 62 Clayton Street, Newcastle-on-Tyne, as agent for the sale of their alternating-current motors in the counties of Northumberland, Durham, Cumberland, Westmoreland and the Cleveland districts of Yorkshire. Mr. Dale has had a wide experience in electrical engineering, and was for several years with the Newcastle-on-Tyne Electric Supply Co., Ltd. He will be prepared to advise intending customers upon all matters connected with electric driving.

Messrs. Electromotors, Ltd., have found it necessary to remove their London office to more commodious premises, and all communications for this office should be addressed to 49, Queen Victoria Street, E.C. The telegraphic address and telephone numbers remain as before.

Fancy Dress Ball.—The first annual Fancy Dress Ball of the Robertson and Osram Social and Athletic Clubs, was held on Saturday, January 8th, when there were 400 present. Among those present were Messrs. C. Wilson, E. G. Sheppard, C. Beaven and Hill. The prizes were presented by Mrs. C. Wilson. The following is the Prize List:—

Gentlemen:

I.—Mr. J. Minson	As Isaacstein Levy "The man who thrives on Free Trade."
II.—Mr. Cartis	Golliwog.
III.—Mr. Harris	George III period.
IV.—Mr. Bergh	Johnnie Walker.

Ladies:

I.—Miss Simmonds	Fare conductor.
II.—Miss Kimpton	Tariff reform.
III.—Miss Williams	Suffragette.
IV.—Miss Bigby	Winter.
V.—Miss Bergh	Jester.

Dissolutions and Liquidations.—John Mitchell and Sons, electrical engineers, Huddersfield.—Messrs. Isaacs and Herbert Mitchell have dissolved partnership. Debts, &c., will be attended to by Mr. Herbert Mitchell, who will continue the business under the old style.

Dalkin & Hardacre, automobile and electrical engineers, &c., Bridge Road, Stockton-on-Tees.—Messrs. J. W. Dalkin, F. D. Hardacre, and F. Hardacre have dissolved partnership. The Messrs. Hardacre will attend to debts and will continue the business as Hardacre Bros.

Fiebig & Frohwein, dealers in electrical accessories, &c., 93, Aldersgate Street, London, E.C.—Messrs. Isidor Frohwein and Alfred Lange have dissolved partnership. Mr. Lange will attend to debts, &c.

Evans & Lloyd, electrical engineers, 188, Inverness Place, Cardiff.—Messrs. J. M. Evans and J. O. B. Lloyd have dissolved partnership.

Sylverlyte Electric Lamp Co., Ltd.—This company is winding up voluntarily, with Mr. Arthur Riding, 15-16, Cockspur Street, S.W., as liquidator. A meeting of creditors is to be held at 72, Goschen Buildings, Henrietta Street, Covent Garden, W.C., on January 19th.

Easton & Anderson, Ltd.—A meeting is to be held at 25, Victoria Street, S.W., on February 15th to hear an account of the winding-up from the liquidator, Mr. W. E. Davies (under the reconstruction scheme commenced December 18th, 1893.)

LIGHTING and POWER NOTES.

Accrington.—The T.C. and the Church U.D.C. have approved of agreements for the transfer to the former body of the Church E.L. order.

Australia.—The Hawthorn Council is negotiating with the Melbourne Electric Supply Co. in regard to an electricity supply. The Boulder (W.A.) municipal authority has decided to raise £8,000 for extensions of its power and lighting plant, including the installation of suction-gas plant. The South Brisbane Council has intimated its intention of applying for an order to enable it to supply electricity in its area, but this power will probably be exercised through a private company.

Bath.—It was reported at a meeting of the T.C. on January 5th that the electric light mains would be extended to Weston as soon as the extension order is passed. The T.C. has applied to the B. of T. for a prov. order to extend the area of supply from the city boundary to a distance of three miles from the Guildhall.

Brandon (Co. Durham).—The R.D.C. has decided to adopt electricity for pumping water at High Brandon, and for lighting the hospital. The pumping plant will be supplied by Messrs. Strakers & Love, the price of energy to be 3¼d. per unit, with 6d. per 1,000 gallons for pumping.

Continental Notes.—HUNGARY.—The Hungarian State coal-mines at Petrozseny and Brdnik are to be provided with a modern plant, and a contract has been placed with Messrs. Ganz & Co., of Buda-Pesth, for the establishment of an electric generating plant of 2,000 H.P. for lighting and power purposes in and about the mines.

An eruption of natural gas has occurred in the district of Kissármás, Co. Kolos, Transylvania. The right to the use of the gas has been bought by the Government, and it is proposed to erect large electrical works on the spot.

GERMANY.—A company is in course of formation at Oehringen, Wurtemburg, with the object of establishing a large electric generating station in the Kocher Valley, between Ohrnberg and Moglingen. No less than 31 local authorities are reported to have signified their willingness to take a supply of energy from the new undertaking.

NORWAY.—The Malangs Falls on the Maalselv river have been purchased by a company with the object of providing electric lighting and power to the new iron ore fields at Ramfjordnaes. The purchasers of the falls are said to be a Norwegian-American company.

Croydon.—At the B.C. meeting on Monday the matter of sinking a well at the generating station, with a view to obtaining water at less cost than by the present arrangement of purchasing it from the public supply, was under discussion. Water is known to exist at a depth of 300 ft., and the estimated cost of the work would be £1,150, a net yearly saving of £325 being possible. On the representation of the Water Committee, however, the matter was deferred for a joint conference.

Dawlish.—The U.D.C. has decided not to object to the transfer of the E.L. order to the newly-formed Electric Supply Co.

Gillingham (Kent).—The T.C. has been asked to submit a special rate for a supply for heating the Naval Hospital.

Grimsby.—Twelve months' notice has been received by the town clerk of the intention of the Grimsby Dock Co. to terminate the agreement under which it receives an electrical supply. Cables are to be laid at an estimated cost of £330 for mains and £80 for a small balancer to supply Mr. Bascomb's farm at Scartho, he having agreed to take current for lighting and heating and to wire 14 cottages.

Hazelgrove and Bramall.—The Stockport T.C. has applied to the U.D.C. for permission to supply energy to consumers in the area of the Council, a number of applications having been received.

India.—In connection with the Tata Iron and Steel Co.'s plant at Kalimate, a large power plant has been installed by the Lahmeyer Electrical Co., this including three turbo-blowers, three turbo-generators, two transformers, two motor-generators, a 150-KW. D.C. set, two air compressors and a switchboard. The turbo-generators are three-phase Lahmeyer machines of 1,250 KVA. output each at 3,000 R.P.M.—the turbines being of the well-known Zoelly type and built by Escher, Wyss & Co.—and are supplied with steam from Babcock & Wilcox boilers. Complete surface condensing plant is provided. The two transformers are each of 625-KVA. capacity of the three-phase oil immersed type with a ratio of 3,000/440 volts, 50 cycles, and the two motor-generator sets each consist of a 750 H.P. synchronous motor driving a 500-KW. 250-volt shunt-wound dynamo. Apart from the blowing engines for the blast furnaces the machinery is practically all electrically-driven, and the works are also lighted electrically. The pumping plant consists of a dozen pumps, with one exception of the rotary type.

Inverkeithing (Fife).—At a meeting of the T.C. a proposal to consider the cost of a generating plant for the electric lighting of the burgh was defeated by 9 votes to 2. Mr. Balfour, of the Dunfermline and District Tramway Co., was present, and explained the details of the proposed tramway to Rosyth and the burgh of Inverkeithing. The Council agreed to give consent to the prov. order, but to retain the power to object to details.

London.—MARYLEBONE.—The Electric Supply Committee has agreed to adopt a tariff for power of 1d. per unit on the restricted hour system, the consumer's supply to be cut off by means of a time switch before and after peak-load times in the winter months. It has been intimated to the Committee that at the forthcoming quinquennial revision of assessments there is every possibility that the undertaking's assessment will be largely increased, and an expert valuer is to be engaged to advise the Council at a fee of 50 guineas.

ST. PANCRAS.—The electrical engineer reports that the new electricity Regulations with regard to factories and workshops came into force at the beginning of the year. There are 32 Regulations which apply to the Council's generating stations, as well as to factories where electricity is adopted as a motive power. The electrical engineer expressed the opinion that they were unnecessarily stringent, but, at the same time, reported that so far as he could ascertain the Council's generating stations and sub-stations complied therewith.

Luton.—The T.C. has received from the L.G.B. sanction to loans of £4,073 for a 500-KW. generating set complete, and additional buildings; £6,600 for mains; and £900 for services. With regard to the application for a loan of £2,046 for a boiler, economiser, &c., the L.G.B. has deferred consideration until tenders for the plant have been obtained.

The T.C. has decided to apply to the B. of T. for a further extension of two years from August 11th, 1910, for completing the unfinished portions of the tramways in the borough.

Macclesfield.—By the casting vote of the chairman, the Gas Committee of the T.C has recommended that the E.L. Order be retained. Although the B. of T. on December 16th deferred for a month only the question of revoking the order, the Council on January 5th decided to defer until the February meeting the consideration of the recommendation.

Reading.—The T.C. has decided to petition against the Reading and District Electric Supply Bill.

Rhyl.—The U.D.C. was on Tuesday informed that the L.G.B. had sanctioned a loan of £3,000 and a supplementary loan of £1,000 for purposes of extension of the electricity undertaking. The extensions involve the sale of an engine valued at £1,250 in the assets of the concern, and the L.G.B. agreed under the particular circumstances to consent to the £1,250 being borrowed for three years on an undertaking that the proceeds of the sale are devoted to its repayment.

St. Helens.—The T.C. has decided to give tradesmen using arc lamps the option of a charge of £1 per annum for the hire of a lamp, and 3d. per unit for energy; an inclusive charge of £4 4s. per lamp per annum, energy to be supplied from dusk to closing time, or an inclusive charge of £3 16s. per annum for lamps owned by users, with a discount of 5 per cent. to persons using six or more lamps.

Experiments are to be carried out with 100 and 200 C.P. tungsten lamps for street lighting.

Electricity is to be supplied to a new church being erected at Haydock, subject to the consent of the new St. Helens and District Tramways Co., the Lancashire Electric Power Co., and the Haydock U.D.C. being obtained. The supply will be given from the tramway feeder.

Sutton Coldfield.—The T.C. has applied for a loan of £3,500 for extending the electric supply to Wylde Green. To meet the annual repayment of £225 in respect of capital charges, the net revenue at the outset is estimated at £180.

Torquay.—The scheme for extending electrical mains to Chelston at an estimated cost of £1,335 is to enlarged so as to include three other roads at an additional cost of £755; also the price of electricity for heating is to be reduced to 1¾d. per unit.

U.S.A.—A recent issue of the *Journal of Electricity* (San Francisco) contains a view of a Westinghouse 22,500-H.P. turbo-alternator set, which will shortly be installed by the San Francisco City Electric Co. Three 5,000 KW. turbine units are now in use, and with the large unit installed a capacity of 30,000 KW. will be available.

West Ham.—With reference to the proposed arrangement for supplying the Port of London Authority with current in a portion of the Royal Albert Docks, outside West Ham, the East Ham Council has consented to West Ham giving the supply subject to the payment of £20 annually for the concession. This has provisionally been accepted, and the Woolwich Council has been asked to receive a deputation to discuss the possibility of arriving at an arrangement in the matter and so obviating an appeal to the B. of T.

Whitwood (Yorks.).—The U.D.C., after considering the E.L. question, has decided to invite Mr. Marsden, engineer to the Houley U.D.C., to make an inspection of the proposed lighting area, and to advise the Council on an amended scheme submitted by the Yorkshire Electric Distribution Co.

Wimbledon.—The T.C. has decided to accept the 1,000-KW. turbo-alternator recently installed by Messrs. J. Howden and Co., Ltd. The actual steam consumptions were slightly in excess of the guarantees, but as they were very low, the engineer recommended that the set be finally accepted. The electrical engineer reported that the total attendance at the electrical exhibition recently held at the Baths was 24,489; that the actual cost of the exhibition was £186 16s., as against the estimate of £160, and that as a result of the exhibition, inquiries and applications were being daily received as to the terms upon which current could be supplied. It was decided that, from April 1st next, the charge for energy supplied for power, cooking and heating be 1d. per unit.

Winchester.—A special committee of the T.C. has recommended that the Council should give immediate notice to the electric supply company to purchase the undertaking, and to request the company not to incur further capital expenditure without obtaining the consent of the Council. A special meeting of the Corporation is to be convened to consider the recommendation.

Worcester.—The T.C. has decided to reduce the price of electricity for heating and cooking to 1d. per unit, with inclusive charges for apparatus.

A showroom is being fitted up for the exhibition of electrical appliances. The contractors of the city protested against the Council entering upon municipal trading, but at a meeting of the Council on January 5th it was stated that there was no intention to trade. Goods would only be exhibited, and any sales would have to be effected through tradesmen.

Worksop.—The U.D.C. has applied to the L.G.B. for a loan of £1,500 for E.L. purposes.

TRAMWAY and RAILWAY NOTES.

Aberdeen.—At the monthly meeting of the Town Council, the Electricity Committee reported on the question of the supply of electrical energy to the Suburban Tramways Co. An opinion of counsel was obtained as to the method of enforcing the award of the arbiter, and the Committee decided to remit the whole matter to the Council for authority to give effect to the advice of counsel that alternative grounds of action as indicated in their opinion be included in the summons. Dr. Westland, convener of the Committee, said another letter had been received from the Suburban Tramways Co., which to some extent receded from the position taken up in the previous letters, and which possibly opened up the matter to further procedure. It was agreed by the Council that the letter mentioned be referred to the Electricity Committee for further consideration and report, and that in the meantime consideration of the Committee's report be deferred.

Accrington.—The T.C. has decided to purchase a motor tower wagon at a cost of about £600. A bonus of 1s. per week is to be paid to the driver on each section of tramways whose weekly record shows the lowest consumption of current.

Australia.—The first six months' working of the Adelaide Municipal Tramways Trust shows a total revenue amounting to £72,669, including £33,863 in respect of electrical lines, and £37,7s2 for the horse lines. Six routes (25½ miles of track) had been converted to electrical working, but had been in use on the average only 13½ weeks. The expenditure amounted in the case of the electric lines to £23,577, and horse lines £39,616, leaving a balance of £9,476 to be carried to net revenue account.

Black Country.—A correspondent writes that "fair fares" are not finding favour in the district. It is contended that not only are the fares, as they work out, much higher than formerly, but that they are very inconvenient, and create confusion. The Brierley Hill U.D.C. has represented to the tramway company that it is anxious that the existing stages should be retained, but that it is inclined to approve the "fair fare system," so far as it relates to distances over or across the existing stages. An interview has taken place between representatives of the Council and Mr. Lycett and Mr. Crump, of the tramway company, and at its conclusion Mr. Lycett promised to carefully reconsider certain suggestions made and report thereon to the Council in due course. The new system was discussed by the Darlaston Council last week, and Mr. C. Foster moved a resolution protesting against the tramway company increasing the fares in the district. The company called it, said Mr. Foster; "fair fares," but it was unfair to the men going backwards and forwards to work, and people travelling to and from the town. He added that it was a shame that the Council had no power to deal with the matter. Mr. Hemming seconded the resolution, which was carried unanimously.

Bolton.—At a meeting of the T.C. held on January 5th, the question of adopting halfpenny fares on the Corporation tramways was under discussion, but it was decided by a large majority not to make any alteration in the present rates.

Continental Notes.—FRANCE.—A new section of the Metropolitan Railway in Paris is on the point of being opened for traffic, which will afford a means of communication right through the city from the north to the south. This is the so-called No. 4 line from the Porte Clignancourt to the Porte d'Orléans, although a portion of the section from the former station to the Châtelet has been in operation for some time past. The remainder of the section to the Porte d'Orléans included work necessitating the construction of two tunnels under the Seine. It will now be possible to accomplish the journey from north to south in about 40 minutes. The lines Nos. 7 and 8 are to be completed by the summer of 1911, and this will complete the first scheme of the Metropolitan Railway network.

SPAIN.—La Société des Tramways Electriques de la Galicie has taken over the concession for the construction and working of an electric tramway between Vigo and Bayona (province of Pontreveda).

RUSSIA.—The Nicolaieff T.C. has decided to borrow about £1,000,000 for various municipal enterprises, including the purchase and electrification of existing tramways (£211,000) and extension of the municipal electrical plant (£21,000).

SWITZERLAND.—Concessions have been granted for the construction and working of electric railways from (1) Waldenbourg to Balsthal, with a branch line; (2) Herzogenbuchsee to Kirchberg, with a branch line; (3) Bienne to Meinisberg; also for an electric tramway from Georgette to Port de Pally.—*Board of Trade Journal.*

A concession has just been granted in respect of a projected narrow-gauge electric railway between Siders and Zermatt.

Japan.—A new electric railway has recently been completed between Shinagawa and Akabane, a distance of 20 miles. The necessary electrical energy is being supplied by the Tokio Railway Co.

London.—In connection with the suburban electrification question, the *Pall Mall Gazette* says that although definite schemes have not yet been accepted, or, indeed, formulated, the boards of several of the companies have had the subject under discussion. The experiment of the Brighton has been closely watched, and the statement, made some time ago, as to the coming extensions of its suburban electrification, has been coincident with careful inquiry by other big companies serving the London suburbs. In two or three cases—and notably the South-Eastern and Chatham and Dover—the directors are wide awake to the necessities of the case, and early developments may be somewhat confidently looked for. It is suggested that the latter company would tackle its Victoria—Brixton—Ludgate Hill section first.

In order to facilitate the working of the L.C.C. Moorgate Street—Finsbury Park tramways, certain widenings and the formation of a new street are to be undertaken in Hoxton, at a cost of £113,020, towards which the County Council has agreed to contribute £96,533, the balance being paid by the Shoreditch B.C. which will carry out the work.

Oldham.—The Tramway Committee has had under consideration the extension to the borough boundary of the Moorside route. The estimated cost of the work is £10,890, and prices are to be obtained from contractors.

St. Helens.—A question was asked upon the minutes of the Highways Committee, at a meeting of the Council on Thursday, as to what was the nature of the differences between the new St. Helens and District Tramways Co. and the Corporation, which it was stated were now pending between the parties and for the settlement of which, arbitrators had been appointed. Alderman Bishop (chairman of the Committee) replied that one of the questions referred to arbitration related to the relaying of the track between Portico and Prescot, the company having alleged that the Committee took too long to carry out the work, and it had made a claim in respect of consequent loss of traffic. The company also claimed for alleged damage to cars caused by the condition of the track on the Haydock route, which, owing to subsidences caused by mining operations, had got out of repair. The Council had no choice in the matter, the company having elected to go to arbitration under the terms of the tramway lease.

South Shields.—At a meeting of the T.C. on the 5th inst., it was recommended by the Parliamentary Committee that the town clerk be instructed to dissent on behalf of the Corporation to the Bill which the North and South Shields Electric Railway Co. had deposited in Parliament for the purpose of reviving the scheme for the construction of a tube railway under the River Tyne. Alderman W. L. Robertson objected to the recommendation, and said it would be a sprag in the wheel of getting any better travelling facilities between the two Shields. Alderman Rennoldson said that surely the Corporation had had a bitter experience in the past with respect to their land in Mile End Road, which the promoters would require for their terminus. The Corporation had been tied hand and foot in regard to the land, and they had lost as much in interest as the land was worth. The town clerk explained that the action intended to be taken was purely a matter of form. The report was adopted.

U.S.A.—In connection with the Chicago railway deal, mentioned in our last issue, it appears that the share holding in four railway companies passes to local capitalists, and it is considered that this will facilitate any scheme for consolidation of the surface lines. This consolidation would be the initial step towards the formation of a public utility company with a capitalisation of 400 million dollars. The railways above mentioned operate 410 miles of single track and carry some 320 millions of passengers per annum.

West Ham.—The tramway manager reports that through running with Walthamstow between Stratford and Chingford Mount, *viâ* Leyton, has been carried out each week-end since September last with satisfactory results. He, therefore, recommended that a regular service should be run for at least 12 months. The Committee has agreed to this.

TELEGRAPH and TELEPHONE NOTES.

Cable Concession.—The *Telegraph Age* states that the concession of the Anglo-American Telegraph Co. in Prince Edward Island expired this year, and it is said that its renewal in favour of that company is doubtful. The company under this concession were granted a subsidy of $5,000 per annum by the Dominion, and $1,800 by the Island.

Cable Repaired.—Paramaribo-Cayenne, January 4th, 1910.

Pacific Cable.—The Pacific Cable Board, we are pleased to note, is apparently determined to compete for traffic on business lines, as permission has just been accorded to issue a special telegram form for use at Postal Telegraph offices, similar to those printed by the Atlantic Telegraph companies. We have often maintained in our columns that more energetic steps should be taken to secure to a British and Colonial Government undertaking the traffic to which it is legitimately entitled, and if proper progress on these lines is made, less will be heard of so-called "deficits."

Sudan.—The telegraph line between Niamey, Zinder, Lake Chad, and Goure, a distance of 930 km., has just been completed.

Telephoning Letters.—The Post Office authorities have made arrangements whereby letters posted in the provinces on Saturday evening, with a special superscription, may be telephoned to subscribers in the London area the first thing on Sunday morning. A special fee of 3d. per 30 words is charged for the accommodation.

Turkish Telephone Concession.—The *Financial News* reports that a French company, jointly with the East European Cable Co., has lodged a protest in the Ottoman Chamber against the grant of the Constantinople telephone concession to the combined French, English and American Syndicate. The French company asks for the contract to be cancelled, and has requested the intervention of the French Ambassador at Constantinople. It also announces its intention, if it does not obtain satisfaction, of bringing an action for 2,000,000 fr. damages.

Uruguay.—The Government intends to vote 8,000,000 fr. for the purpose of establishing its own telephone system, which will work in competition with the systems owned by two private undertakings.

World's Telegraphs.—The Bureau International de l'Union Télégraphique has just issued a new nomenclature of the telegraph offices of the world. The cost is 5 fr., including postage. The new map showing the telegraph cables and lines of the world has also come to hand.

CONTRACTS OPEN and CLOSED.

OPEN.

Acton.—January 18th. Electrical supplies for the U.D.C. for one year. See "Official Notices" January 7th.

Australia.—Melbourne.—February 2nd. Electrically-driven pump for the City Council. See "Official Notices" December 10th.

Melbourne.—Seven sections of branching multiple magneto switchboard for the P.M.G. See "Official Notices" January 7th.

Wireless telegraph installation (*a*) in or near Sydney, N.S.W., and (*b*) in or near Fremantle, Western Australia. See "Official Notices" January 7th.

Sydney.—Two junction-line sections of common-battery switchboard for the P.M.G. See "Official Notices" December 24th.

South Australia.—Telegraph and telephone material for the P.M.G. See "Official Notices" December 24th.

Belfast.—January 31st. Two water-tube boilers, superheaters, mechanical stokers, economisers, pipework, &c., for the Tramways and Electricity Department. See "Official Notices" January 7th.

Belgium.—January 31st. The municipal authorities of Waremme are inviting tenders for the concession for the electric lighting of the town.

February 18th.—Tenders to Hotel de Ville, Ostend, for the supply and erection of eight electrically-operated travelling cranes at the port of Ostend. Full particulars of the contract can be obtained from M. Gevaert, Ingenieur-en-Chef, Directeur des Services d'Etudes et de Controle des Applications de l'Electricité, 38, Rue de Louvain, Brussels.

February 26th.—Tenders will be received at the Hôtel de Ville, Bree, province of Limbourg, for the establishment of a central electrical station in connection with the provision of electric light to the town. Plan and conditions at Hôtel de Ville, Bree.

Birmingham.—February 1st. Stores for the Tramways Department. See "Official Notices" December 31st.

Bristol.—January 31st. Electric lighting of the passenger station at the Royal Edward Dock, Avonmouth, for the Council's Dock Committee. See "Official Notices" to-day.

Cheltenham.—January 29th. E.L. fittings for a year, for the T.C. J. S. Pickering, Borough Surveyor.

Eccles.—January 15th. 150-kw. steam engine and D.C. dynamo for the Corporation electricity undertaking. See "Official Notices" December 24th.

Halifax.—February 7th. Stores and materials for the Corporation Tramways and Electricity Departments. See "Official Notices" to-day.

Launceston (Tas.).—February 7th and March 21st. (*a*) About 1,100 tons of steel tram-rails and fastenings; (*b*) rail bonds and accessories. Regarding (*a*) apply to Messrs. J. Terry and Co., 7, Great Winchester Street, London, E.C.; regarding (*b*) apply to Town Clerk, Town Hall, Launceston. Deposit one guinea in each case.

London.—Stepney.—January 24th. Boilers and accessories; turbo-generator accessories; converting plant; switchgear, &c., for the B.C. Electricity Supply Committee. See "Official Notices" January 7th.

February 4th.—The Institution of Electrical Engineers is inviting tenders for a complete system of electrically-opesated clocks for its new premises. See "Official Notices" to-day.

Islington.—January 27th. Electrical and engineer's stores, &c., for one year for the Council. See "Official Notices" to-day.

Manchester.—January 18th. Steel tramway poles for the Tramways Committee. Mr. J. M'Elroy, general manager. Deposit two guineas.

Newport (Mon.).—January 24th. Stores for the Electricity and Tramway Department. See "Official Notices" to-day.

Plymouth.—January 25th. Stores for the Corporation Electricity and Street Lighting Departments. See "Official Notices" January 7th.

Stone (Staffs).—January 19th. E.L. and telephone installation at the new Isolation Hospital, Yarnfield, for the Joint Hospital Board. W. W. Wynne, Clerk, 21, High Street, Stone.

Wallsend.—The T.C. on 4th inst., on the recommendation of the Fire Brigade Sub-Committee, decided to obtain prices for the installation of an electric system for calling the firemen.

CLOSED.

Australia.—An Australian contemporary reports that Messrs. Noyes Bros. (Sydney), Ltd., have secured an order for a 180-kw. Allen-Westinghouse set for the Abermain Colliery, West Maitland, N.S.W. This set is to provide power for pumping, and for the extra coal cutters now being installed.

Birkenhead.—The Education Committee has accepted the tender of Messrs. S. J. Edwards & Son for installing the E.L. at the Well Lane and Cathcart Street Schools, at £178 10s.

Bradford.—The T.C. has accepted the tender of Hadfield's Steel Foundry Co., Ltd., for manganese steel curved rails for track renewals, at £1,137 10s.

Canada.—A Canadian electrical exchange states that the Canadian Light and Power Co. has contracted with J. G. White and Co., New York, for the construction of a hydro-electric plant on the St. Lawrence River, near St. Timothee, Que. The plant will utilise the Beauharnois Canal water, giving an available and constant head of 50 ft. The power station will contain three 7,200-h.p. turbine units coupled to 4,000-kw. generators, and have space for a fourth unit; also two 400-h.p. exciter units and switchgear. The 27-mile transmission line to Montreal and sub-station and distributing system at that city will also be included in the contract, which is estimated to cost about $4,000,000.

The Toronto Board of Works has awarded the contract for the supply of copper wire for electrical purposes to the Canadian General Electric Co., Ltd., at 16$\frac{1}{10}$ cents per pound.

Cardiff.—Messrs. A. G. Arnold & Son, of Newport, have secured the contract for the electric lighting of Roath Park Congregational Church.

Chatham.—The T.C. has accepted the tender of Rayfield and Jenner, to supply Osram lamps, 28, 35, and 55-watt, 100-volt, at £17 2s. per gross.

Dundee.—The installation of electric light in the Steeple Church will be carried out by J. Mackersie & Co.

Germany.—The Siemens-Schuckert Gesellschaft, of Berlin, has secured a contract for the extension of the central electric lighting station at Wreschen (Posen), at an estimated cost of £75,000.

Hull.—The Corporation has placed an order with Messrs. Siemens Bros. Dynamo Works, Ltd., for 20 33-h.p. tramway motors and controllers. The motors are fitted with commutation poles, and the controllers are arranged according to the new Siemens system described in our issue of September 24th, 1909, in which the series-parallel system is combined with control by shunting the fields. The order was placed after exhaustive comparative tests had been made on this type, against motors run with the ordinary s.-p. control and regenerative motors.

London.—St. Pancras.—The following tenders were received for a new switchboard at the King's Road station:—

British Thomson-Houston Co., Ltd.		£87 15
Northcote, Heaver & Co.	(accepted)	90 19
Bertram Thomas		95 5
E. F. May, Ltd.		109 0
A. Seage & Co.		115 0

Lynton (Devon).—The tender of the Lynton and Lynmouth E.L. Co. has been accepted for the installation of the electric light at the new Wesleyan Church.

West Bromwich.—The T.C. has accepted the tender of the Electric Construction Co., Ltd., for a booster.

FORTHCOMING EVENTS.

Institution of Civil Engineers.—Tuesday, January 18th. At 8 p.m. Discussion on "The Design of Rolling Stock for Smooth-Rail Working on Heavy Gradients," by Mr. F. W. Bach, and paper on "The Reconstruction of the Tyne North Pier," by Mr. I. C. Barling.

Faraday Society.—Tuesday, January 18th. At 8 p.m. At the I.E.E. Papers on "The Conditions which Determine the Composition of Electro-deposited Alloys. Part II—Silver-Copper," by Mr. S. Field; "Studies in the Electro-deposition of Metals," by Messrs. F. Mollwo Perkin and W. E. Hughes; and other papers.

Institution of Electrical Engineers (Manchester Students' Section).—Tuesday, January 18th. At 7.30 p.m. At the Municipal School of Technology, Manchester. Paper on "The High Tension Spark Discharge in Air," by Messrs. P. Kemp and W. A. Stevens.

Royal Society of Arts.—Wednesday, January 19th. At 8 p.m. Paper on "The Japan-British Exhibition, 1910," by Count H. Mutsu.

Institution of Electrical Engineers (Students' Section).—Wednesday, January 19th. At 7.45 p.m. Paper on "Collection of Current at High Peripheral Speeds," by Messrs. P. J. Cottle and J. A. Rutherford.

Physical Society.—Friday, January 21st. At 5 p.m. At the Imperial College of Science, South Kensington, S.W. Papers on "The Polarisation of Dielectrics in a Steady Field of Force," by Prof. W. M. Thornton; and "The Use of Mutual Inductometers," by Mr. A. Campbell.

Institution of Mechanical Engineers.—Friday, January 21st. At 8 p.m. Paper on "Ninth Report to the Alloys Research Committee: on the Properties of some Alloys of Copper, Aluminium and Manganese," by Dr. W. Rosenhain and Mr. F. C. A. H. Lantsberry.

Northampton Institute Engineering Society.—Friday, January 21st. At 5.45 p.m. Paper on "Choice of Prime Movers for Power Stations," by Mr. E. T. Driver.

THE ELECTRICAL ENGINEERS
(LONDON DIVISION).

The following orders are issued:—

Commanding Officer—Col. R. E. B. Crompton, C.B.

Monday, January 17th.—"A" Company. Technical drill, 7 to 9.30 p.m.
Tuesday, January 18th.—"B" Company. Technical drill, 7 to 9.30 p.m.
Wednesday, January 19th.—Gymnasium, 6.30 to 9.30 p.m.
Thursday, January 20th.—"C" Company. Technical drill, 7 to 9.30 p.m.
Friday, January 21st.—"D" Company. Technical drill, 7 to 8.30 p.m.; infantry drill, 8.45 to 9.45 p.m.
Saturday, January 22nd.—"A" Company. Week-end run at Coalhouse Fort. Parade at Fenchurch Street Station 3.15 p.m. Service dress with putties and greatcoat. Toilet requisites to be carried in haversack.

(Signed) P. H. Campbell, Capt. R.E. and Adjutant.
For O.C. E.E., L.D.

NOTES.

A Fund Opened for Mr. Harry Cox.—The sad case of Mr. Harry W. Cox, who has experienced, and is destined to continue to suffer for the remainder of his days, such painful consequences from his pioneering work in connection with X-rays, is well known to our readers. It will be remembered that a grant of £200 was made by the Government, but that is a recognition which is quite inadequate under the circumstances, and the matter calls for personal assistance from very many people who feel admiration for those who, in the development of so valuable an aid to medical and surgical science, have themselves become seriously disabled. Upon the many thousands of men and women who have received actual benefit in their own persons, or in the circle of their families, from the use of X-rays in diagnosing their complaints, Mr. Cox, and other like sufferers, have a very strong claim. We hesitate to describe Mr. Cox's terrible condition—a few words will suffice. One finger of the left hand was amputated, and the entire hand is now withered. The right hand and arm have been amputated, the latter only three weeks ago. The face, mouth and chin were next attacked, and for four years they have been gradually eaten away. There is a massive growth projecting from the floor of the mouth. Mr. Cox is 46 years of age, is nursed by his wife, and has three sons, of 12, 14 and 16 years of age respectively. We are glad to learn that a "Cox Fund" has been opened by Sir William Treloar, and a first list of subscriptions appeared in the *Daily Telegraph* yesterday. The Electrical Review is anxious to bring this fund to the notice of its readers, and hopes that there will be a hearty and generous response. In this way it should be possible in some small degree to ease the very serious burden of disadvantage under which the "victim to science," as he has been termed, is placed. Subscriptions should be sent to the "Cox Fund," 69, Ludgate Hill, E.C., and cheques should be crossed London, City and Midland Bank, Ludgate Hill.

Electro-Harmonic Society.—The concert held last Friday was decidedly above the average; every item in the first half, if we mistake not, was encored, and, judging by the applause, those in the second half would have been similarly honoured had time permitted. The chair was occupied by Mr. Tennant, who makes an exceptionally good chairman; we regret to say that very few of the Committee were present to support him.

Inquiry.—The maker of the "King-o-lite" candle lamp is asked for.

Southport Explosion.—The inquest on William Saunders, who died from burns resulting from an explosion at the Southport Corporation Electricity Works in November last, should have been held on Wednesday last week. It was stated, however, that John Hesketh another man who was severely burnt at the same time, was still in the infirmary, and could not be present. Inspector Clarke said that the healing process had only just commenced, and the doctors said fully two months would elapse before the man would be able to attend Court. The inquiry was adjourned until March 9th.

His Honour Judge Thomas, of the Southport County Court, on Tuesday dealt with the sum of £221 paid into Court by the Southport Corporation with respect to the death of William Saunders. His Honour ordered £50 to be paid in lump to the widow and the balance to be paid in monthly instalments of £2 10s.

Board of Trade Electrical Standards.—By order in Council, published in the *London Gazette* of January 11th, the electrical standards set up at the Board of Trade Standardising Laboratory, Whitehall, and approved in 1894, are declared to be in agreement with the values of the International Electrical Units as defined at the International Conference in October last, within the limits of accuracy originally prescribed, namely, for the ohm, 0·01 per cent.; for the ampere and volt, within 0·1 per cent. The only modification required is that the temperature of the standard ohm is raised from 15·4° C. to 16·4° C. As we have previously pointed out, the close agreement between the original standards and those adopted by the Conference reflects the greatest credit upon the skill and foresight of the designers of the Board of Trade standards, and upon the staff entrusted with their maintenance.

Electrical Trades Benevolent Institution: Second Annual Dinner.—The second festival dinner of this Institution will be held on Wednesday, February 23rd next. Dr. Gisbert Kapp, President of the Institution of Electrical Engineers, has consented to preside.

Institution and Lecture Notes.—The Institution of Civil Engineers (Students).—At the students' meeting on January 7th, Mr. D. S. Richardson, Stud.Inst.C.E., read a paper on "Oil Fuel."

Society of Engineers.—The "Status Prize," an annual premium for the next four years, will be awarded by the Society for the best paper written by any person on the subject of "How to Improve the Status of Engineers and Engineering, with Special Reference to Consulting Engineers," and will consist of books or instruments to the value of three guineas. Essays must be received on or before May 31st by the Secretary, 17, Victoria Street, S.W., from whom further particulars may be obtained.

Iron and Steel Institute.—The annual general meeting will be held at the Institution of Civil Engineers, Great George Street, London, S.W., on May 4th and 5th, 1910. The annual dinner will be held at the Hotel Cecil on May 4th. Candidates for Carnegie Research Scholarships must apply before February 28th to the offices of the Institute. The autumn meeting will be held at Buxton on September 27th, 28th and 29th, 1910. The International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology will be held at Düsseldorf in the last week of June, 1910. Members who wish to attend must apply before February 26th to the offices of the Institute. Amongst the subjects dealt with at the Congress will be winding and haulage, mine drainage, the utilisation of blast-furnace gases, the electrical production of steel, the driving of rolling mills with electricity, electric power stations, pumping, fans, cranes, conveyors, &c.

Allowing Credit for Exports to Canada.—A letter appeared in Tuesday's *Times* from Mr. F. C. T. O'Hara, Deputy Minister of Trade and Commerce at Ottawa, Canada, in which he alludes to the many instances that come before him of the utter indifference of the exporters from the United Kingdom to Canadian trade. He cites a case "the most glaring and amazingly stupid" ever brought to his notice. It appears that the "—— Electric Co., Ltd., of London," received an order for sample goods to the value of £1 8s. from the Ottawa Electric Co., but they asked for a remittance first before shipping the goods, as the Ottawa Co. had not made arrangements for payment to be made against bill of lading in London. Mr. O'Hara adds:—

"Thus for a trifling order of £1 8s.—and this a sample order—a rebuff is administered to one of the most enterprising of the electric companies in Canada, and a company enjoying a high financial reputation. This company is dismissed and curtly told 'this is contrary to our usual practice.'

"I venture to say that there is no electric concern in the whole of the United States who would not have promptly shipped the goods without even bothering to look up the commercial standing of this company for such a trifling order.

"Can it be said that it is such instances as this that have contributed to the following statement of dutiable imports of electrical apparatus into Canada during the last fiscal year?

Imported from the United States—$1,937,371
" " United Kingdom—$91,092."

Metric System.—The Danish Government has decided that the metric system shall be employed in Denmark from April 1st next in all matters relating to Customs and taxation, in accordance with an Act passed in 1907. The system will be adopted in commercial transactions in April, 1912.

Late Legal.—The British Aluminium Co., Ltd.—The affairs of the British Aluminium Co., Ltd., were again before the Court on Wednesday last, when the two adjourned petitions for compulsory orders which had been presented by Dick, Kerr and Co., Ltd., and A. Schonfield & Co., came before Mr. Justice Neville in the Companies' Winding-up Court. Mr. Frank Russell, K.C., for the first petitioners, said that he understood that a further adjournament was desired, and he had no objection. Mr. Younger, K.C., on behalf of the company, said that it was commercially solvent, and the petitions had stood over from day to day to give an opportunity of maturing a scheme for reconstruction. The difficulty, however, of procuring a scheme had been very great owing to the great number of interests that had to be considered. A scheme was now on the point of being submitted for approval, and it provided for the unsecured creditors being paid in full. Under those circumstances he asked that the petitions might stand over until the first petition day in March next. Mr. Hamilton, K.C., said that he represented creditors for a very large amount, and he supported an adjournment. Mr. Stewart Smith, for the second petitioners, also assented to the matter standing over, and his Lordship adjourned both petitions until March 2nd.

Anglo-Spanish Copper Co., Ltd.—A petition for the winding-up of this company, presented by the Romanera Copper Co., Ltd., and Another, was also before the Court, but stood over until Tuesday next for the purpose of enabling the petitioners to answer the evidence filed by the company in opposition.

London Electrobus Co., Ltd.—Mr. Hart, on a petition of T. Langley, for the winding-up of the London Electrobus Co., Ltd., stated that the petitioner's debt had been satisfied, and he was willing that the petition should be dismissed, without costs. This was assented to, and his Lordship dismissed the petition accordingly.

Bruce's Patents Co., Ltd.—Mr. D. R. Bruce, an inventor of a patent coupling for electric cables, petitioned for the winding-up of Bruce's Patents Co., Ltd., in which he was a shareholder. The petitioner's case was that he was induced to part with his patent to the company in exchange for 3,000 fully-paid shares, and a large number of shares were allotted to the promoters who were to provide the working capital. No working capital was, however, found, and the petitioner was desirous of getting a winding-up order so as to free his invention. His Lordship thought the petitioner as a shareholder had made out no case for a winding-up, and accordingly dismissed the petition.

Annual Dinner.—The thirteenth annual dinner of the electrical staff of the North Staffordshire Railway Co. was held at the North Stafford Hotel, Stoke-on-Trent, on Saturday, January 8th, Mr. Andrew F. Rock, M.I.E.E., electrical engineer and superintendent, presiding. The vice-chairs were occupied by Mr. Colin Roberts and Mr. H. A. Lewis, and there were about 60 present. An excellent dinner was followed by a capital programme of toasts and music. Sympathetic allusion was made by Mr. Rock and others to the late Mr. James Heath, a genial figure at all previous gatherings.

Appointments Vacant.—Chief clerk and accountant for Croydon electricity works (£180 rising to £230); clerk and collector for Bridlington Electricity Committee (£90); working foreman engineer (mechanical and electrical) for Middlesex County Asylum, Napsbury, near St. Albans (£130 + house, coals, &c.). See our advertisements to-day.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Officials.—Worcester T.C. has appointed Mr. Fox, of the electricity staff, as canvasser at 30s. per week, and a commission of 2½ per cent. up to £250 for new consumers, and 5 per cent. beyond that amount.

Mr. Uffleman having resigned his position in the Sales Department of West Ham undertaking, Mr. T. O. Wilton (formerly canvasser) has been appointed to fill the vacancy at £2 10s. per week and commission.

The marriage of Mr. E. Poole, assistant borough electrical engineer of Durban (Durban correspondent of the Electrical Review), to Miss Olive Maud Royal, took place on December 9th at the Congregational Church, Beira, Durban, in the presence of a large number of friends. The bridgroom was the recipient of a canteen of cutlery from the staff of the Electrical Department with whom he had been associated for the past 10 years.

Mr. D. M. MacLeod, who has held the post of chief mains engineer to the Clyde Valley Electrical Power Co. for several years, has been appointed resident engineer of the company.

Tramway Officials.—Last week the staff and employés of the Sunderland District Electric Tramways, Ltd., presented the resident manager and engineer, Mr. G. Stratton, with a roll-top desk and a Sheraton bureau on the occasion of his approaching marriage.

General.—We regret to read in a Birmingham paper that Mr. George Conaty, consulting electrical engineer, of Colmore Row, formerly general manager of the Birmingham and Midland Tramways, is lying seriously ill with double pneumonia. In consequence he was unable to give evidence on behalf of the Handsworth Council at the Greater Birmingham inquiry last week.

Obituary.—Sir W. Lloyd Wise.—We regret to record the death, at the age of 64 years, of Sir W. Lloyd Wise, the well-known Patent Law authority, and founder of the Institute of Patent Agents.

Mr. Julius Wallach.—We regret to learn of the death of Mr. Julius Wallach, senior managing director of the firm of Wallach Bros., Ltd., who has been in failing health for some time past. The business of the firm will continue to be conducted as hitherto.

CITY NOTES.

European Electro-Chemical Companies.—The Usines Electrochimiques de Hafslund, of Geneva, which are principally engaged in the production of carbide of calcium and ferro-silicon at the works at Hafslund, Norway, report an increase in the turnover in 1908-9, although prices had to be reduced in consequence of the general situation of trade. After meeting working expenses and appropriating £11,100 for depreciation, the company realised net profits of £18,300, which have allowed of the payment of a dividend of 10 per cent. on the share capital of £90,000, being the same rate as in the preceding year. On the other hand, the Carbidwerk Lechbruck, of Augsburg, which has a share capital of £55,000, has been unable to pay any dividend since the formation of the company. The accounts for 1908-9 show a surplus of £2,150, as compared with £2,470 in the previous 12 months, and the amount has again been applied to the purpose of depreciation. The Usine Electriques de la Lonza, of Gampel, in the canton of Vallais, which is also engaged in the manufacture of carbide of calcium and iron alloys, experienced an unfavourable period in 1908-9, although this is mainly attributed to the depreciation of securities. The accounts exhibit a loss of £18,900 as contrasted with net profits of £28,900 in 1907-8, when a dividend of 5 per cent. was declared on the share capital of £480,000.

Chile Telephone Co., Ltd.—The directors have declared an interim dividend of 3s. per share for the past half-year.

Direct United States Cable Co., Ltd.—The directors recommend an interim dividend of 4s. per share, free of income-tax, being at the rate of 4 per cent. per annum for the quarter ended December 31st, 1909, placing £7,500 to reserve fund, and carrying forward £6,859.

Siemens & Halske Co.—At the general meeting on January 7th a shareholder complained of the paucity of the information contained in the directors' report. In reply, it was stated on behalf of the board that in other circles the brevity of the report had been regarded as commendable, as it thereby gave no occasion for suppositions. The board declined to give information of individual transactions, such as the construction of an underground railway to the Nonnendamm, as they related to funding business, and it would, therefore, be a great mistake for a prudent management to express itself on the subject. As to the course of business in the current year, it was mentioned that the total orders received had again shown an increase. It had, however, to be taken into consideration that some departments were not fully employed, as customers, particularly local authorities, were still very reserved in the placing of orders, but on the other hand, other departments were occupied to the extreme limit of their capacity. The receipt of orders in the case of the Siemens-Schuckert Works Co. had also been entirely satisfactory down to the present time, although the depression in prices continued in consequence of keen competition for large contracts. Nevertheless, the sales business, particularly in the customary products of repute, was developing in a very satisfactory degree. It was added that the impression undoubtedly prevailed that unless unforeseen events occurred, the current year would also yield satisfactory results.

Mexican Light and Power Co.—The directors have declared a dividend of 1 per cent. on the ordinary shares.

Prospectus.—*Kuala Pahi Rubber Estate, Ltd.*—This company has been offering 480,000 shares of 2s. each for subscription at par. The estate is in the State of Kelantan, Malay States.

Dublin United Tramways Co. (1896), Ltd.—The directors, subject to final audit, recommend dividends for the half-year to December 31st at the rate of 6 per cent. per annum, less income-tax, on both the preference and the ordinary shares, after setting aside £15,000 towards the renewal of permanent way and carrying forward £9,267. The amount at the credit of net revenue account includes a sum of £8,150, payable in respect of income-tax over-assessed for the past six years.

Rio Tramway, Light and Power Co., Ltd.—The directors have declared a dividend of 1 per cent. on the issued capital stock.

Stock Exchange Notices.—The Committee has ordered the following securities to be quoted in the Official List:—Kaministiquia Power Co.—$50,000 vendors' 30-year five per cent. gold bonds of $1,000 each, Nos. 826 to 875. Manáos Tramways and Light Co.—Fully-paid scrip for £300,000 five per cent. first debentures of £100 each, Nos. 1 to 3,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight.		No. of wks.	Total to date.		Route miles open.	
		£	£*		£	£*		Inc.
Aberdeen	Jan. 5	2,923	+ 241	31	44,382	— 855	..	..
Ayr	,, 8	408	+ 3	24	10,716	— 153	8	..
Bath	,, 5	1,628	+ 77	52	89,859	+ 1,579	..	..
Belfast	,, 7	7,671	+ 502	39	155,015	+ 5,812	87	..
Birkenhead	,, 9	2,869	+ 340	40	43,781	— 39	13·63	..
Birmingham Corp.	,, 1	14,838	+1,399	40	263,761	+ 8,690	..	..
Blackburn	,, 5	2,357	+ 56	41	44,996	— 1,367	14·13	..
Blackpool Corp.	,, 6	985	— 190	..	50,883	+ 4,250	..	..
Blackpool-Fleetw'd	,, 8	561	+ 71	52	22,982	+ 1,479	..	..
Bolton	,, 2	4,881	— 49	40	93 161	+ 190	26	..
Bournemouth	,, 5	3,171	+ 443	40	67.696	+ 728	21·96	..
Bradford	,, 1	9,965	+ 742	39	195,335	+ 6,905	54·81	..
Brighton	,, 9	1,656	+ 319	41	40,057	+ 1,939	9·5	..
Bristol	,, 7	12,117	+1,923	..	..	..	..	..
Brit. Elec. Trac. Co.								
Airdrie	Dec. 31	491	— 21	52	11,371	— 207	3·65	..
Barnsley	,, 31	403	+ 1	,,	8,-35	— 406	..	..
Barrow	,, 31	482	+ 56	,,	12 084	— 570	5·87	..
Cavehill	,, 31	140	+ 5	,,	4,388	— 121	..	..
Devonport	,, 31	866	— 148	,,	19,228	— 5,148	8·85	..
Gateshead	,, 31	2,214	— 30	,,	54,070	— 692	11·25	..
Gravesend	,, 31	474	+ 58	,,	10,495	+ 91	6·5	..
Greenock	,, 31	1,064	+ 173	,,	28,719	+ 1,678	7·25	..
Hartlepool	,, 31	504	+ 41	,,	12,170	— 63	6·72	..
Kidderminster	,, 31	280	+ 22	,,	5,591	— 125	..	..
Leamington	,, 31	318	+ 12	,,	9,109	+ 205	..	..
Merthyr	,, 31	454	— 23	,,	10,908	— 289	2·9	..
Metropolitan	,, 31	14,714	+3,211	,,	226,443	+26,631	23	..
Middleton	,, 31	535	— 97	,,	17,080	— 1,185	8·5	..
Mid. Joint Com'tee	,, 31	13,615	+1,084	,,	299,957	+ 18	..	..
Oldham—Ashton	,, 31	1,955	— 42	,,	29,036	— 1,356	9·13	..
Peterborough	,, 31	279	+ 27	,,	6,164	— 418	5·81	..
Potteries	,, 31	3,813	— 465	,,	94,251	— 317	29	..
Rothesay	,, 31	87	— 14	,,	10,002	+ 88	2·75	..
Southport	,, 31	499	+ 15	,,	14,627	— 475	8·17	..
S. Metropolitan	,, 31	1,780	+ 261	,,	41,512	— 430	..	..
Swansea	,, 31	2,220	+ 237	,,	51,152	+ 1,904	13·5	..
Tynemouth	,, 31	307	+ 53	,,	12,944	+ 876	3·75	..
Weston-s Mare	,, 31	74	+ 25	,,	7,239	+ 417	3	..
‡Worcester	,, 31	503	+ 83	,,	14,455	— 135	5·75	..
Wrexham	,, 31	233	+ 20	,,	5,128	— 214	..	..
Yorks. Wool. Dist.	,, 31	1,958	+ 6	,,	48,111	+ 487	17	..
Miscellaneous	,, 31	441	+ 40	,,	10,876	+ 271	..	..
Burnley	Jan. 8	2,669	— 474	..	..	..	..	..
Burton-on-Trent	,, 9	551	— 31	41	10,896	— 179	6·68	..
Bury	,, 2	2,275	+ 11	39½	46,146	— 409	23·5	..
Cardiff	,, 1	4,140	+ 324	40	88,005	+ 1,448	..	..
Carlisle	,, 8	354	+ 45	52	8,563	— 448	..	..
Chatham and Dist.	,, 6	1,741	+ 334	52	42,832	+ 1,900	14·98	..
Cork	,, 6	969	+ 99	52	23,464	— 580	9·82	..
Croydon	Dec. 24	3,398	+ 5·4	..	61,072	+ 5,739	11·25	4·75
†Darlington	Jan. 8	376	+ 20	41	7,575	— 496	..	..
Darwen	,, 7	510	+ 45	40	10,085	— 111	4·36	..
Dover	,, 1	362	+ 46	40	8,440	— 356	4·75	..
Dublin	,, 7	10,437	+ 148	..	..	..	54·25	..
Dundee	,, 5	2,772	+ 131	39½	40,156	— 682	15·5	..
East Ham	,, 8	2,050	+ 261	4 ½	49,938	+ 4,903	8 52	·77
Exeter	,, 7	616	+ 52	41	13,646	+ 610	5·5	..
Glasgow	,, 8	37,338	+1,907	..	588,528	— 8,040	94½	5
Hastings	,, 6	1,778	+ 371	..	..	..	..	..
†Huddersfield	,, 1	1,948	+ 452	39	66,246	+ 3,998	28·3	·5
Hull	,, 8	6,742	+ 711	40	106,005	+ 4,800	14·5	1·5
Ilkeston	,, 5	249	+ 14	40	5,410	— 239	..	..
Ipswich	,, 8	743	+ 94	41	16,409	+ 232	10·5	..
Kilmarnock	,, 1	808	— 42	33	4,847	— 242	4·25	..
Lancashire United	,, 5	2,871	— 257	52	67,779	— 819	39	..
Leeds	,, 1	18,841	+ 709	39	270,493	+ 7,915	..	..
Leicester	.. ..	..	..	..	..	..	..	..
Leith	,, 8	1,369	— 166	34	20,702	+ 2,401	9	3
Liverpool	,, 1	22,584	+ 998	52	560,118	— 1,811	..	..
‡L.C.C.	Dec. 25	78,778	+7,468	..	1,433,828	+72,449	..	..
London United	Jan. 8	11,925	+2,192	..	..	..	..	..
Lowestoft	,, 1	256	+ 30	14	2,267	+ 57	3·5	..
Manchester	,, 8	30,580	+2,539	41	608,914	— 6,681	..	..
Newcastle	,, 1	5,188	— 89	..	154,785	— 1,801	14·5	..
Newport	,, 1	1,432	+ 167	40	26,277	— 126	14·5	..
Oldham	,, 9	3,449	+ 103	41	75,190	— 5,597	18·75	..
Pontypridd	,, 8	795	+ 137	40½	16,721	+ 1,124	5·5	..
†Portsmouth	,, 1	1,949	+ 666	40	83,338	+ 2,874	14·5	..
Preston	,, 5	1,601	+ 149	..	..	..	..	..
Rotherham	,, 6	1,416	+ 207	40	23,033	— 949	12	2
Salford	,, 8	9,601	+ 587	39½	181,980	— 3,956	..	..
Sheffield	,, 9	12,597	+1,1 6	41½	215,605	— 4,192	..	..
Southampton	,, 7	2,139	+ 292	40	45,241	— 94	..	..
Southend-on-Sea	,, 5	779	+ 211	40	21,475	+ 2,898	..	..
South Shields	,, 8	1,179	+ 90	40½	23,006	+ 48	..	..
Swindon	.. ..	..	..	..	..	..	..	..
Tyneside	,, 5	742	— 82	..	..	..	..	..
Wallasey	,, 8	1,727	+ 149	40	37,402	+ 808	..	..
Walthamstow	,, 8	1,807	+ 813	41	26,925	+ 898	5	..
West Ham	Dec. 30	5,187	+ 709	39	22,657	+ 5,869	15·25	·43
Wolverhampton	Jan. 5	1,069	+ 168	40	34,277	+ 873	14·25	1·75
Baker St.-Waterloo	,, 8	6 965	— 185	26	83 090	+ 2,810	4·25	..
Cen. London Rly.	,, 8	10.460	— 622	26	138,716	—42,301	5·82	·55
Char. +, Ens. Hamp.	,, 8	7,915	+ 210	26	97,995	+ 3,390	7·75	..
City & S. Lon. Rly.	,, 9	7,231	— 151	26	83,440	+ 3,121	7·3	..
Dublin-Lucan Rly.	,, 7	228	+ 4	26	3,672	+ 26	7	..
G.N. and City Rly.	,, 8	3 162	— 100	26	35,728	+ 348	3.5	..
G.N., P'y. & Brmm.	,, 8	12,175	+ 555	26	142,595	+ 7,180	9·25	..
L'pool Overh'd Rly.	,, 9	2,642	— 7	..	..	..	6·8	4·2
Llandudno-Col. Bay	,, 7	290	+ 54	5½	650	+ 43	..	..
Mersey Railway	,, 8	4,219	+ 235	26	51,891	+ 1,977	4·5	..
Metropolitan Rly.	,, 9	34 096	+1,186	26	427.769	+ 672	24·5	..
Met. District Rly.	,, 8	21,331	+1,897	26	261.028	+16,640	24	..
Anglo-Argentine	.. 7	93.103	+3,666	52	2,077,202	+124 582	..	..
‖Auckland	Dec. 3	14,816	+1,292	48	164,769	+14,899	22·3	1·36
Bombay (B.E.T.)	,, 9	5.671	+ 320	49	125,542	+ 6.649	..	..
‖Brisbane	,,	18,380	+1,675	52	198,322	+20,739	..	..
‖Brit. Columbia Rly.	.. ..	..	..	..	..	..	..	..
†Calcutta	Jan. 8	7,527	+ 370	..	..	..	..	..
‖CapeElectricT.Ld.	.. ..	..	..	..	..	..	..	..
‖Kalgoorlie, W.A.	.. ..	3,399	..	..	41,472	..	20·5	..
Madras	Dec. 15	1,405	+ 221	..	29,729	+ 1,511	..	..
‖Lisbon	.. ..	..	..	..	..	..	..	..
Perth (W.A.)	Jan. 7	3,910	+ 468	52	74,455	+ 1,115	26	2·4

* Compared with the corresponding period of 1908. † One week only.
Includes horse, steam and other receipts. ‖ One month.

STOCKS AND SHARES.

Tuesday Afternoon.

WITH the General Election so near at hand, and everybody—protesting they are sick of politics—talking of little else but the infamous lies told by the other side, the Stock Exchange finds public interest in its markets distinctly on the ebb. The easier condition of the money market has done the Stock Exchange only a slender amount of good, and for another week or two the political controversy will, no doubt, completely swamp financial matters.

The Home Railway market is moving erratically and nervously. Prices are up on one day, and down the next, the labour troubles in the coal districts being the mainspring of the various fluctuations. When the difficulties are said to be settled, prices advance; when the fears of a strike are uppermost, down go the quotations.

The electrical group of railway stocks is working, more or less, independently of the others; but Metropolitans, which had been flat, firmed up to 40¼, thus showing no loss on the week. Districts, however, are lower. No quotable changes have taken place in Central Londons, nor in City and South London.

Before long, the three latest Tubes will have ceased to exis separately, and the prices of the Debenture stocks are now close to one another. Baker Street and Waterloo Debenture is 98, with a 2 per cent. dividend to come off later in the week. Charing Cross Debenture is 94, and Great Northern, Piccadilly and Brompton 94½, both of these having gone *ex* dividend at the end of December.

London United Tramways 4 per cent. Debenture recovered a point to 59½, other British tramways issues being unaltered. Anglo-Argentine Tramways First Preference drooped, and Mexico Trams lost half their rise of last week, although the latter company's 5 per cent. bonds are ½ better. Rio Trams fell 1¼ to 93, and Sao Paulo trams at 152½ are a point down.

A feature in these markets has been the further rise in Canadian General issues, the Common at 121 being 5 points to the good, and the Preference at 119½ showing an advance of 2, on steady buying orders.

Mexican Electric Light and Power shares have gained 2 points; otherwise, the list is uninteresting—not to say stupid. Of the London shares, Charing Cross Ordinary, London Electric Preference, and City of London Preference are both better, and City Second Debenture at 100½ is 1 higher. As a steady 4½ per cent. investment, it is likely that the last-named security appeals to many investors in this class of undertaking. North Metropolitan Electric Power Supply 5 per cent. Mortgages are 1 better at 100 middle.

The mainstay of business in the Industrial Market continues to be the great activity in rubber shares. What surprises the observer more than anything else is the remarkable consistency of the movement, the rise being so prolonged and reactions so rare. Dealers in the market had looked for a quiet time between now and April, many of the chief dividend declarations being due in the latter month. But the demand for Rubber shares, especially from the Continent, is insatiable, and so prices soar gaily to levels at which the cautious ask whether it is not wise to sell and to allow others to take a hand in a game that is apparently becoming dangerous.

Further revision of the dividend anticipations in the case of Anglo-American Telegraph Deferred stock has led to another shrinkage in the price—this time, however, of merely a small fraction. The Preferred stock fell ½. Western Telegraphs are ½ up. Marconi's shares, after their rise, lost part of it, in spite of the paragraphs which have been appearing with reference to the application of the company's system to fresh customers. The Eastern group is quietly firm, and the Trust companies' descriptions have not moved. Amongst telephone shares, a fall of ⅛ in National Third Preference is the solitary alteration, and manufacturing shares are extremely quiet.

Schuckert Co.—The recent general meeting of the Elektrizitäts Gesellschaft vorm. Schuckert & Co. approved the payment of a dividend for 1908-9, as previously announced, at the rate of 6 per cent. Herr Petri, general director, held forth the prospect of favourable results for the current year, but at the same time he stated that the impending taxation reform in Bavaria would place an additional burden to the extent of 60 per cent. of the present taxes paid by the company, whilst the fresh impost would amount to 50 per cent. in the case of the Continental Company for Electrical Enterprises. The director added that agriculturists were devoting more attention to the advantages of electricity, and the company in association with its subsidiary companies was at present engaged on the construction of 10 overland central stations.

SHARE LIST OF ELECTRICAL COMPANIES

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Shares. *	Dividends for the last four years. 1906.	1907.	1908.	1909.	Closing Quotations Jan. 4th.	Closing Quotations Jan. 11th.	Business done week ended Jan. 11th, 1910. Highest	Lowest.	Rise + or Fall —	Present Yield per cent. £ s. d.
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	8⅜ – 8¾	8⅜ – 8¾	..	..	..	Nil.
136,700	Do. do. 5 % Debs., Nos. 1 to 1,365 Red.	100	5 %	5 %	5 %	5 %	99 – 102 xd	99 – 102	..	..	..	4 18 0
$131,551,400	American Telephone & Telegraph, Cap. Stock ..	$100	8 %	8 %	8 %	8 %	143 – 145 xd	143 – 145	144½	..	..	5 10 5
$58,000,000	Do. Collat. Trust, 4% Bonds, 1 to 58,000 and 68,001 to 78,000	$1000	4 %	4 %	4 %	4 %	94 – 96 xd	94 – 96	..	..	..	4 3 4
558,460	Anglo-American Telegraph	Stock	5⅝%	5⅝%	£3 4s.	..	60 – 62	60 – 62	..	..	..	5 8 4
3,220,770	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	..	100 –101	99½ –100½	100½	99⅜	— ½	5 19 1
3,220,770	Do. do. do. Deferred	Stock	2⅛	1 %	8/-	..	21½ – 21⅝	21½ – 21⅝	21⅝	21 7/16	— ⅛	1 17 3
47,725	Anglo-Portuguese Tel., 5 % Mort. Deb. Stock Red.	100	5 %	5 %	5 %	..	101 –103	101 –103	..	..	..	4 17 1
44,000	Chili Telephone, Nos. 1 to 44,000	5	8 %	8 %	8 %	..	7⅞ – 8⅛	7⅞ – 8⅛	8	..	..	4 18 6
2,481,850	Commercial Cable, Sing. 500 year 4% Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	85 – 87 xd	85 – 87	86½	85½	..	4 12 0
16,000	Cuba Telegraph	10	5 %	6 %	6 %	..	8⅝ – 9⅛	8⅝ – 9⅛	..	..	..	6 9 9
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	..	17 – 18	17 – 18	..	..	..	5 11 1
12,981	Direct Spanish Telegraph, Ord.	5	10 %	10 %	10 %	..	8 – 8¼	8 – 8¼	..	..	..	5 14 8
6,000	Do. do. 10 % Cum. Pref. ..	10	4 %	4 %	4 %	..	8 – 8½	8 – 8½	..	..	..	6 5 0
80,000	Do. do. 4½ % Debs.	5	10 %	10 %	10 %	..	8 – 8½	8 – 8½	..	..	..	4 9 1
60,710	Direct United States Cable	100	4½%	4½%	4½%	4½%	99 –101 xd	99 –101	18½	18	..	6 4 7
89,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,908, R.	Stock	7 %	7 %	7 %	..	13 – 13½	13 – 13½	..	..	..	4 10 0
4,000,000	Eastern Telegraph, Ord. Stock	100	8½%	8½%	8½%	..	98 –100 xd	98 –100	..	..	..	5 2 2
2,000,000	Do. 8½ % Pref. Stock	Stock	4 %	4 %	4 %	..	134 –137	134 –137	136	135½	..	4 0 6
1,896,706	Do. 4 % Mort. Deb. Stock. Red. ..	10	7 %	7 %	7 %	..	85 – 87	85 – 87	85½	85	..	5 19 11
200,000	Eastern Extension, Australasia, and China Tele	Stock	4 %	4 %	4 %	..	102 –104	102 –104	..	..	..	5 12 0
753,400	Do. 4 % Deb. Stock	10	7 %	7 %	7 %	..	12 – 12½	12 – 12½	12 7/8	12⅜	..	3 16 11
800,000	East. & S. Afric. Tel., 4 % Mt Db. Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	..	103 –104	103 –104	104⅛	..	..	3 16 11
181,127	Globe Telegraph and Trust	10	5½%	5½%	5½%	..	99 –101	99 –101	..	..	..	3 19 8
181,127	Do. do. 6 % Pref.	10	6 %	6 %	6 %	..	10⅜ – 10⅞	10⅜ – 10⅞	10⅝	10⅜	..	5 6 1
150,000	Great Northern Telegraph, of Copenhagen	10	30 %	30 %	18 %	..	13½ – 13⅝	13½ – 13⅝	13 7/16	13 1/16	..	4 7 8
5,000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	98 –100 xd	98 –100	..	..	..	5 18 0
17,000	Indo-European Telegraph	25	12 %	12 %	12 %	..	50½ – 52½	50¼ – 52½	51½	50½	..	4 10 0
$41,380,400	Mackay Companies Common	$100	8½%	4 %	4 %	4⅛%	93 – 95	93 – 95	..	..	..	7 2 10
$50,000,000	Do. do. 4% Cum. Pref.	$100	4 %	4 %	4 %	4 %	78 – 80	78 – 80	..	..	..	4 4 8
294,190	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	..	3⅛ – 3⅜	3⅛ – 3⅜	15/-	13/-	+ 3/9	5 0 0
72,680	Monte Video Telephone Co., Ltd. Ord.	1	6 %	6 %	6 %	..	5/16 – ⅜	5/16 – ⅜	..	..	..	N 1
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅜ – ½	⅜ – ½	..	..	..	6 8 0
2,235,000	National Telephone, Pref. Stock	100	6 %	6 %	6 %	..	106½ –108	106⅝ 108	107½	107½	..	5 6 8
3,735,000	Do. do. Def. Stock	100	5 %	6 %	6 %	..	123 –125	123 –125	123½	..	..	5 11 1
15,000	Do. do. 6 % Cum. 1st. Pref.	10	6 %	6 %	6 %	..	10⅜ – 11⅛	10⅜ – 11⅛	..	..	..	4 16 0
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	..	10½ – 11	10½ – 11	..	..	..	5 8 4
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	..	5 5/16 – 5 7/16	5⅜ – 5⅝	5½	5 5/16	— 1/16	5 9 1
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	97 – 99 xd	97 – 99	..	..	..	4 8 11
1,968,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	98½ –100½ xd	98½ –100½	..	..	..	3 10 9
179,318	Oriental Telep. and Elec. 1 to 171,504, fully paid ..	1	7 %	8 %	8 %	..	1⅜ – 1½	1⅜ – 1½	..	..	..	3 19 7
50,000	Do. do. do. 8 % Cum. Pref. ..	1	6 %	6 %	6 %	..	1 15/16 – 1 31/32	1 15/16 – 1 31/32	..	..	..	5 5 9
99,100	Do. do. do. 4 % Red. Deb. Stock ..	100	4 %	4 %	4 %	4 %	86 – 88 xd	86 – 88	..	..	..	4 14 9
99,400	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	10	4 %	4 %	4 %	4 %	100 –102	98 –100 xd	..	..	..	4 10 11
11,899	Reuter's	8	5 %	5 %	5 %	..	7⅞ – 8¼	7⅞ – 8¼	..	..	..	4 0 0
145,355	Telephone Co. of Egypt, 4½ % Deb. Red.	100	4½%	4½%	4½%	4½%	99 –101 xd	99 –101	..	..	..	4 18 9
3,042	Submarine Cables Trust	Cert.	6 %	6 %	6 %	..	129 –132	129 –132	..	..	..	4 9 1
120,000	United River Plate Telephone	5	8 %	8 %	8 %	..	6⅞ – 7⅛	6¾ – 7⅛	7	..	..	4 7 5
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	6 %	..	5⅝ – 5⅞ xd	5⅝ – 5⅞	..	..	..	5 13 8
80,008	W. Coast of America, 1 to 30,000 & 58,001 to 58,008	2½	2½%	2½%	2½%	..	1⅝ – 1⅞	1⅝ – 1⅞	..	..	..	4 8 11
160,000	Do. 4 % Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	4 %	98 –100 xd	98 –100	99	98½	..	3 16 4
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980 ..	10	7 %	7 %	7 %	..	13½ – 14 xd	13⅝ – 14⅛	14	13⅝	..	4 0 0
800,000	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	101 –103 xd	101 –103	..	..	..	5 2 11
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜ – ½	⅜ – ½	..	..	..	3 17 8
84,558	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	..	8⅛ – 9⅛	8⅛ – 9⅛	..	..	..	Nil
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	£2 6	15 %	..	8 – 9	8 – 9	..	..	..	6 9 9
80,000	Do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	5 %	100 –102 xd	100 –102	..	..	..	6 18 4
												4 18 0

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

640,000	Anglo-Argentine Trams, 5 % Cum. 1st Pref., 1 to 640,000	5	..	..	..	..	4½ – 4⅝ xd	4 7/16 – 4½	91/9	88/9	— 1/16	5 6 1
500,000	Do. 5 % 2nd Pref., 500,001 to 1,000,000	5	..	..	..	..	4½ – 4⅝ xd	4½ – 4⅝	86/10½	85/7½	..	5 11 1
978,280	Do. 4 % Deb. Stock	Stock	..	..	..	..	90½ – 92 xd	90½ – 92	91½	91	..	4 7 0
882,887	Auckland E. Trams, 5 % 1st Mort. Deb. Stock ..	100	5 %	5 %	5 %	5 %	102 –105 xd	102 –105	104	..	..	4 15 3
680,000	Babcock & Wilcox, 1 to 680,000	1	20 %	20 %	20 %	..	4⅜ – 4⅝	4⅜ – 4⅝	..	..	..	4 3 9
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	6 %	6 %	6 %	..	1 7/16 – 1½	1 7/16 – 1½	..	..	..	3 19 2
80,000	British Aluminium, Ord., 1 to 40,000	1	6 %	6 %	Nil	..	1 – 1⅛	1 – 1⅛	..	..	..	Nil
60,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	..	1⅜ – 1½	1⅜ – 1½	..	..	— ⅛	10 0 0
40,100	Do. do. "A" 6 % Cum. Pref.	5	7 %	7 %	3½ %	..	1⅜ – 1½	1⅜ – 1½	..	..	— ⅛	8 5 6
12,897	Do. do. 4 % Funding Certs.	5	6 %	6 %	6 %	..	3⅛ – 3½	3⅛ – 3½	..	..	..	6 11 1
124,400	Do. do. 5½ % Loch Leven Debs. ..	5	4 %	4 %	2 %	..	2⅜ – 3⅛	2⅜ – 3⅛	..	..	..	5 10 0
500,000	British Columbia E. Rail Def. Ord. Stock	100	5½%	5½%	5½%	..	97 – 100	97 – 100	..	..	..	5 9 7
400,000	Do. Pref. Ord. Stock	100	6 %	8 %	8 %	..	142 –146	142 –146	..	..	..	4 16 9
400,000	Do. 5 % Cum. Perp. Pref. Stock	100	5 %	5 %	6 %	..	121 –125	121 –125	122½	..	..	4 8 6
400,000	Do. 4½ % 1st Mort. Debs., 1 to 6,250	100	5 %	5 %	5 %	..	110 –113	110 –113	111	..	..	4 0 7
233,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	4½%	4½%	4½%	..	102 –104	102 –104	..	..	..	4 6 7
212,600	British Electric Traction	10	Nil	Nil	Nil	..	102 –105	102 –105	..	..	..	4 6 2
188,801	Do. do. 6 % Cum. Pref.	10	6 %	3 %	1½%	..	⅝ – 1	⅝ – 1	..	..	..	Nil
161,497	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	..	2⅝ – 3	2⅝ – 3	55/-	86	85½	5 0 0
1,478,653	Do. do. 4½ % 2nd Deb. Stock Red.	100	4½%	4½%	4½%	..	84 – 87	84 – 87	..	..	..	6 14 11
598,986	British Insulated and Helsby Cables	5	10 %	10 %	10 %	..	60 – 65	60 – 65	..	..	..	7 10 0
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	..	7 – 7½	7 – 7½	..	..	..	6 19 4
100,000	Do. do. 4½ % 1st Mort. Deb. Red. ..	100	4½%	4½%	4½%	..	6½ – 6⅝	6½ – 6⅝	..	..	..	4 10 7
500,000	Do. do. 4½ % 1st Mort. Debs.	100	4½%	4½%	4½%	4½%	101 –104 xd	101 –104	..	..	..	4 6 7
804,940	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	4½%	4½%	4½%	4½%	89 – 94	89 – 94	89½	..	..	4 15 9
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 75,000	5	Nil	Nil	Nil	..	½ – ⅝	½ – ⅝	11/6	..	..	Nil
1,916,883	Do. do. 4 % Mort. Deb. Stock ..	100	4 %	4 %	4 %	..	46 – 50 xd	46 – 50	..	..	..	8.0 0
50,000	Browett, Lindley & Co., Ord.	1	Nil	Nil	Nil	..	15/16 to 15/8	15/16 to 15/8	..	..	..	Nil
50,000	Do. do. 6 % Cum. Pref.	1	Nil	Nil	Nil	..	0 – ⅛	0 – ⅛	..	..	..	Nil
140,976	Brush Electrical Engineering, Ord., 1 to 105,751 ..	2	Nil	Nil	Nil	..	0 – ⅛	0 – ⅛	..	..	..	Nil
200,000	Do. do. Non-cum. 6 % Pref.	2	Nil	Nil	Nil	..	0 – ⅛	0 – ⅛	..	..	..	9 15 8
135,000	Do. do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	..	41 – 46	41 – 46	..	..	..	15 3 0
135,000	Do. do. 4½ % Perp. 2nd Deb. Stock..	Stock	4½%	4½%	4½%	..	25 – 29 xd	25 – 29	..	..	..	4 10 0
197,610	Calcutta Trams, 1 to 197,610	5	8 %	6 %	4½%	..	4½ – 5	4½ – 5	..	..	..	5 2 7
45,804	Do. 5 % Cum. Pref., Nos. 1 to 39,320..	5	5 %	5 %	5 %	..	4⅜ – 4½ xd	4⅜ – 4⅞	..	..	..	4 3 3
350,000	Do. 4½ % 1st Deb. Stock..	100	4½%	4½%	4½%	4½%	99 –102 xd	99 –102	..	..	..	6 19 4
95,000	Callender's Cable Construction shares	5	15 %	15 %	15 %	..	10 – 10⅜	10 – 10⅜	..	..	..	4 10 11
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5¼ – 5½ xd	5¼ – 5½ xd	5⅜	..	..	4 6 2
800,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	102½ –104½ xd	102½ –104½	..	..	..	Nil
491,223	Cape E. Trams., 1 to 491,223	1	Nil	Nil	Nil	..	1/16 – 1/8	1/16 – 1/8	..	..	..	Nil
450,000	Castner-Kellner Alkali, 1 to 450,000	1	8 %	12 %	12½%	..	2½ – 2⅝	2½ – 2⅝	47/6	..	..	5 5 3
210,158	Do. do. 4½ % 1st Mort. Deb. Stock	100	4½%	4½%	4 %	..	105 –108	105 –108	..	..	..	3 14 1
1,890 690	Central London Railway, Ord. Stock	Stock	4 %	3 %	3½%	..	67 – 69	67 – 69	67¼	67	..	4 14 2
554,655	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	..	86 – 88	86 – 88	87	..	..	4 10 11
554,655	Do. do. Def. do.	Stock	6 %	2 %	2½%	..	48 – 50	48 – 50	..	..	..	5 0 0
1,480,000	City and South London Railway	Stock	2½%	3½%	1¼%	..	33 – 34	33 – 34	33½	33½	..	4 8 3
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	5 %	Nil	..	⅜ – ½	⅜ – ½	..	..	..	Nil
100,000‡	Do. 5 % 1st Mort. Reg. Debs., 1 to 999 of £100, and 991 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	88 – 91 xd	88 – 91	..	..	..	5 9 11

* Unless otherwise stated, all shares are fully paid. ‡ From Manchester Share List.

Continued on next page.

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(*Continued.*)

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1906.	1907.	1908.	1909	Closing Quotations Jan. 4th.	Closing Quotations Jan. 11th.	Business done week ended Jan. 11th, 1910. Highest	Lowest.	Rise + or Fall —	Present Yield per cent. £ s. d.
260,000	Dick, Kerr & Co., 1 to 260,000	1	10 %	10 %	6 %	..	1 — 1⅛	1 — 1⅛	..	..	..	6 9 0
805,000	Do. do. 6 % Cum. Pref., 1 to 805,000	1	6 %	6 %	6 %	..	1⅛ — 1⅛	1⅛ — 1⅛	..	..	+ ⅛	5 1 1
271,080	Do. do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	98 — 101 xd	98 —100	..	..	— ½	4 10 0
60,000	Dublin United Trams. (1896), 6 % Pref., 1 to 60,000	10	6 %	6 %	6 %	..	12⅜ — 13⅜	12⅜ — 13⅜	12⅜	..	..	4 7 8
99,261	Edison & Swan Utd., "A" shs., £8 pd., 1 to 99,261	5	4½%	2½%	Nil	..	⅞ — 1	⅞ — 1	..	..	..	Nil
17,189	Do. "A" shares, £1—017,189	5	4½%	2½%	Nil	..	1 — 1⅛	1 — 1⅛	..	..	..	Nil
807,895	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	64 — 69 xd	64 — 69	..	..	..	5 15 11
67,720	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	..	81 — 84	81 — 84	..	..	..	5 19 1
112,100	Electric Construction, 1 to 112,100	2	Nil	Nil	Nil	..	⅞ — 1	1⅛ — 1⅛	..	..	..	Nil
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	..	1⅛ — 1⅛	1⅛ — 1⅛	..	..	..	10 4 0
75,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	7⅞ — 8⅛ xd	7⅞ — 8⅛	..	..	..	6 1 3
2 0,000	Do. do 4 % Mort Deb.	Stock	4 %	4 %	4 %	..	83 — 87	83 — 87	..	..	..	4 12 0
78,000	Gt. N. & City Rail. Pref. Ord. "A" 4 %, 1 to 78,000	10	4 %	½ %	Nil	..	⅜ — ⅝	⅜ — ⅝	..	..	..	Nil
98,000	Greenwood & Batley, 7 % Cum. Pref.	10	7 %	7 %	..	..	10½ — 10⅝	10⅝ — 10⅝	..	..	..	6 10 8
60,000	Do. do. 5 % Mort. Debs.	100	5 %	5 %	5 %	..	102 — 103	102 —103½	..	..	+ ½	4 16 10
40,000	Henley's (W. T.), Telegraph Works, Ord.	5	5 %	15%	15 %	..	12 — 12⅝	12 — 12⅝	12⅛	..	..	5 17 8
40,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	..	5 — 5⅛	5 — 5⅛	5 1/16	..	..	4 3 9
150,000	Do. do. 4½ % Mort. Deb. Stock	Stock	4½%	4½%	4½%	..	104 — 106	104 —106	..	..	..	4 4 11
50,000	India-Rubber, Gutta-percha & Telegraph Works.	10	0 %	10 %	10 %	..	15 —15⅜ xd	15 — 15⅜	..	..	..	6 7 0
87,500	†Liverpool Overhead Railway, Ord.	10	Nil	½ %	Nil	..	⅜ — ½	⅜ — ½	..	..	..	Nil
12,000	† Do. do. Pref., fully paid	10	5 %	5 %	5 %	..	4½ — 5	4½ — 5	..	..	..	10 0 0
600,070	London United Trams. (1901), 1 to 50,007	10	3 %	3 %	Nil	..	1⅛ — 2⅛	1⅛ — 2⅛	..	..	..	Nil
899,980	Do. do. 50,008 to 100,000	10	3 %	3 %	Nil	..	1⅛ — 2⅛	1⅛ — 2⅛	..	..	..	Nil
125,000	Do. do. 5 % Cum. Pref., 1 to 125 000	10	5 %	5 %	3½%	..	1⅜ — 2⅛ xd	1⅜ — 2⅛	88/9	..	..	16 13 4
1,649,230	Do. do. 4 % 1st Mort. Deb. Stock	100	4 %	..	4 %	4 %	57 — 62 xd	58 — 63 xd	..	..	+ 1	6 7 0
5,722,062	Metropolitan Consolidated	100	1 %	½%	½%	..	40 — 40⅛	40 — 40⅛	39⅞	39⅝	..	1 4 8
2,640,914	Do. Surplus Lands	100	2½%	2½%	2½%	..	66 — 68	66 — 68	67⅛	66⅛	..	4 0 11
3,285,000	Do. District	100	Nil	Nil	Nil	..	18 — 18⅛	17⅞ — 18⅛	18	17⅞	— ⅛	Nil
891,337	Metropolitan Electric Trams., Ord.	1	..	..	4½%	..	⅛ — ⅛	⅛ — ⅛	..	..	..	6 10 11
314,016	Do. do. Defd.	1	Nil	Nil	Nil	..	⅛ — ⅛	⅛ — ⅛	..	..	..	Nil
800,000	Do. do. 5 % Cum. Pref.	1	5 %	5 %	5 %	..	⅞ — 1	1⅛ — 1⅛	..	..	..	6 3 1
595,600	Do. do. 4½ % Deb. Stock Red.	100	4½%	4½%	4½%	4½%	92 — 95 xd	92 — 95	94	93⅞	..	4 14 9
$10,823,200	Mexico Trams Co., Common Stock	..	..	..	..	..	..	..	..	..	–1⅛	..
$7,000,000	Do. 1st Mort. 50-year 5% Gld. Bds.	..	..	..	5 %	..	91½ — 93⅜	92 — 94	93⅜	92⅜	+ ½	5 6 5
245,500	Potteries Electric Traction	1	4 %	4 %	Nil	..	⅜ — ½	⅜ — ½	..	..	..	..
245,500	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	..	⅝ — ¾	⅝ — ¾	..	..	..	6 17 11
245,000	Do. 4½ % Deb. Stock	100	4½%	4½%	4½%	..	84 — 87	84 — 87	..	..	..	5 3 6
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	15 %	..	34½ — 36	34½ — 36	35⅛	34⅛	..	5 8 0
140,000	Do. 4 % Deb. Bds., 1 to 1,500 Red., 1909	100	4 %	4 %	4 %	4 %	99 —101 xd	99 —101	..	..	..	3 19 3
1,000,000	Underground Electric Railway, 5% Prior Lien	..	..	..	5 %	..	100½ –101⅛	100⅛–101⅛	101⅛	101⅛	..	4 18 6
2,800,000	Do. do. 4½% Bonds	..	..	..	4½%	..	87 — 89	87 — 89	88⅛	87⅛	..	5 1 2
4,900,000	Do. do. 6% Income Bonds	..	..	..	..	..	84 — 86	84 — 86	..	..	..	..
66,666	Willans & Robinson, 1 to 80,000 & 80,001 to 116,666	1	Nil	10 %	5 %	..	⅛ — ⅜	⅛ — ⅜	7/6	..	..	..
66,666	Do. 6 % C.P., 80,001 to 80,000 & 125,001 to 141,666	6	..	6 %	6 %	..	1½ — 2⅛	1⅝ — 2⅛	..	..	..	2 8 4
245,495	Do. % 1st Mort. Deb. Stock		4 %	4 %	4 %	..	72 — 77	72 — 77	..	..	..	5 1 3

ELECTRICITY SUPPLY COMPANIES.

15,000	Bromley (Kent) E.L. & P., 1 to 15,000	5	5⅓%	5⅓%	5⅓%	..	4½ — 4⅝	4½ — 4⅝	..	..	..	5 15 9
70,000	Do. do. 4½ % 1st. deb. stock	100	4½%	4½%	4½%	..	91 — 94	91 — 94	..	..	..	4 18 9
80,449	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	10%	10 %	10 %	..	7 — 7⅛	7⅛ — 7⅜	7⅜	7⅜	+ ⅛	6 1 3
9,951	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	..	7 — 7⅛	7⅛ — 7⅜	..	..	+ ⅛	4 4 10
400,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	..	99 —102	59 —102	..	..	..	3 18 5
80,000	Charing Cross and Strand Electricity Supply	5	5 %	5 %	5 %	..	3⅞ — 4⅛	4 — 4⅛	87/-	83/9	+ ⅛	5 11 1
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	..	4⅛ — 4⅜	4⅛ — 4⅜	83/9	..	..	4 17 4
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	..	3¾ — 4	3¾ — 4	..	..	..	5 0 0
445,736	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	99 — 99 xd	96 — 99	97	..	..	4 0 10
49,435	Chelsea Electricity Supply, Ord.	5	4½%	4½%	4½%	4½%	3⅞ — 3⅞	3⅞ — 3⅞	..	..	..	6 4 2
175,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	..	99 —101 xd	98 —101	..	..	— ½	4 9 1
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	6 %	6 %	6 %	..	10½ — 10⅝	10½ — 10⅝	..	..	..	5 11 8
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	..	11⅝ — 12⅝	12 — 13	12⅝	..	+ ½	4 12 4
400,000	Do. 5 % Db. Stk.	Stock	5 %	5 %	5 %	5 %	120 —124 xd	120 —124	121⅜	..	..	4 0 8
800,000	Do. 4½ % 2nd. Db. Stk.	100	4½%	4½%	4½%	4½%	98 —101 xd	99 —102	..	..	+1	4 8 3
50,000	County of Durham Electrical Power, Ord.	5	4 %	2 %	..	..	1½ — 2	1½ — 2	..	..	..	5 0 0
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	..	2⅞ — 3⅛	2⅞ — 3⅛	..	..	..	7 8 2
250,000	Do. do. do. 5 % 1st Mtg. Deb.	Stock	..	..	5 %	5 %	91 — 93 xd	91 — 93	..	..	..	5 7 6
40,000	County of London Electric Lighting, Ord. 1—40,000	10	5 %	5 %	5 %	5 %	7⅛ — 8	7⅛ — 8	..	..	..	6 5 0
55,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	..	10⅝ — 11⅛	10⅝ — 11⅛	10½	10⅜	..	5 7 10
400,000	Do. do. 4½ % Deb. Stock	Stock	4½%	4½%	4½%	4½%	103 —106 xd	103 —106	105	103⅝	..	4 4 11
400,000	Do. do. 4½ % 2nd. Deb. Stock	Stock	4½%	4½%	4½%	..	99 —101	98 —101	..	..	..	4 9 1
80,000	Edmundson's Electric Corporation, Ord. Shares	5	Nil	Nil	Nil	..	⅛ — ⅜	⅛ — ⅜	..	..	..	Nil
10,000	Do. do. 5 % Cum. Pref.	5	5 %	Nil	Nil	..	⅜ — ½	⅜ — ½	..	..	..	Nil
434,500	Do. do. 4½ % 1st Mort. Deb. Stk.	100	4½%	4½%	4½%	..	57 — 60	57 — 60	..	..	..	7 10 0
$1,150,000	Electrical Dev.Co.of Ontario, 5% 1stMtg.Gold Bnds.	$500	..	..	5 %	5 %	89 — 92 xd	89 — 92	..	..	..	5 8 8
10,000	Folkestone, 1 to 10,000	5	5⅓%	5⅓%	5⅓%	..	4⅜ — 4⅝	4⅜ — 4⅝	..	..	..	5 12 10
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	5 %	5 %	5 %	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..	..	4 13 0
90,000	Do. 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	..	97 —100	97 —100	..	..	..	4 10 0
15,000	Hove, 1 to 15,000	5	9 %	8½%	8½%	..	6⅞ — 7⅛	6⅞ — 7⅛	..	..	..	5 18 4
$1,876,000	Kaministiquia Power Co., 5 % Gold Bnds.	100	..	..	5 %	5 %	100 —102 xd	101 —103	102½	101½	+1	4 17 1
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	8 %	..	7 — 7⅛	7 — 7⅛	..	..	..	5 4 1
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	..	95 — 98	95 — 98	..	..	..	4 1 8
111,000	London Electric Supply Corporation, Limited, Ord.	3	4 %	2½%	3 %	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..	4 4 3
70,000	Do. do. do 6 % Pref.	5	6 %	6 %	6 %	..	4⅜ — 5	4⅜ — 5⅛	100/-	96/3	..	6 0 0
862,355	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4½%	4½%	4 %	4 %	90 — 93 xd	90 — 93	91½	..	..	4 6 0
800,000	Metropolitan Electric Supply, 1 to 100,000	5	8 %	6½%	5 %	..	4 — 4⅛	4 — 4⅛	85/-	84/1½	..	5 11 1
78,121	Do. 4½ % Cum. Pref. 1—71,106	5	4½%	4½%	4½%	..	4⅜ — 5 xd	4⅜ — 5	96/3	..	..	4 10 0
285,000	Do. 4½ % 1st Mort. Deben. Stock	Stock	4½%	4½%	4½%	4½%	104 —107 xd	104 —107	..	..	..	4 4 1
248,000	Do. 3½ % Mort. Deben. Stock Redeem.	Stock	3½%	3½%	3½%	3½%	83 — 86 xd	83 — 87	..	..	..	4 1 5
$3,000,000	Mexican Electric Light Co., 5% 1st Mtg. Gold Bnds	100	5 %	5 %	5 %	..	79 — 81 xd	77 — 81	80⅜	80½	..	6 8 5
$8,585,000	Do. Light and Power Co., Ltd., Common	$100	..	..	3½%	..	68 — 70	68 — 70	69⅛	68⅛	..	5 0 0
$1,400,000	Do. do. 7% Cum. Pref. Stk.	Stock	..	..	7 %	..	100 —104	100 —104	102	..	..	6 14 7
$12,000,000	Do. do. 5% 1st Mtg. Gold Bnds.	100	..	..	5 %	..	86 — 88	83 — 90	89⅝	88⅜	+2	5 11 1
950,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	..	96 — 98	96 — 98	..	..	..	4 11 10
180,491	Newcastle-on-Tyne, 1 to 187,500	5	8 %	8 %	2½%	..	3⅜ — 4⅛	3⅜ — 4⅛	..	..	..	2 16 9
187,500	Do. 5 % Pref., 1 to 187,500	5	5 %	5 %	5 %	..	3⅜ — 4⅛	3⅜ — 4⅛	92/6	..	..	5 17 8
126,500	North Metropolitan Electric Power Supply Co., 5 % Mortgages (Red.), Nos. 1 to 1,265	100	..	..	..	5 %	98 —100	99 — 101	..	..	+1	4 19 0
10,852	Notting Hill Electric Lighting	10	7½%	7½%	7 %	..	12½ — 13⅛	12⅞ — 13⅛	..	..	..	5 6 0
20,000	Oxford, 1 to 96 and 407 to 20,310	5	7 %	7 %	..	..	6 — 6⅛	6 — 6⅛	..	..	..	5 7 8
50,000	Do. 4 % Deb. Stock	100	4 %	4 %	4 %	..	95 — 98	95 — 98	..	..	..	4 1 8
119,694	River Plate Electy. Co. Ord. Nos. 1 to 120,507	1	2½%	6 %	8 %	..	1⅜ — 1⅝	1⅜ — 1⅝	31/6	31/3	..	4 18 6
100,000	Do. do. 6% Non Cum. Pref. Nos. 1 to 100,000	1	6 %	6 %	6 %	..	1⅝ — 1⅞	1⅝ — 1⅞	..	..	..	5 19 0
200,000	Do. do. 5% Deb. Stk. Red.	100	5 %	5 %	5 %	5 %	101 —104 xd	101 —104	..	..	..	4 16 2
40,000	St. James' and Pall Mall Electric Light, Ord.	5	10 %	10 %	10 %	..	8½ — 9	8½ — 9	..	..	..	6 7 0
90,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	..	7 — 7⅛	7 — 7⅛	..	..	..	5 11 1
160,000	Do. do. 8½ % Deb. Stock Red.	100	8½%	8½%	8½%	8½%	83 — 87 xd	83 — 87	..	..	..	4 0 6
12,000	Smithfield Markets Electric Supply, Ord.	5	Nil	Nil	Nil	..	1½ — 2	1½ — 2	..	..	..	Nil
85,000	South London Electric Supply, Ord.	4	3 %	4 %	5 %	..	2⅜ — 2⅝	2⅜ — 2⅝	..	..	— 1/16	9 6 1
120,000	South Met. Elec. Lt. & Power, Ord.	1	2½%	2½%	2½%	..	⅝ — ¾	⅝ — ¾	..	..	..	4 8 11
142,968	Do. do. 7 % Pref.	1	7 %	7 %	7 %	..	1⅛ — 1⅛	1⅛ — 1⅛	..	..	..	5 17 11
294,528	Do. do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	..	100 —103	100 —103	..	..	..	4 7 5
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	..	⅜ — ½	⅜ — ½	..	..	..	25 6 8
60,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	1½ — 1⅝	1½ — 1⅝	..	..	..	14 5 4
275,000	Do. do. 4½ % 1st Mort. Db. Stk. Red.	100	4½%	4½%	4½%	..	74⅛ — 78⅛	74⅛ — 78⅛	..	..	..	5 14 8
808,000	Victoria Falls Power Co., Pref. Nos. 1 to 808,000	1	..	..	5 %	..	⅛ — ⅜	⅛ — ⅜	..	..	— 1/16	6 6 8
100,000	Westminster Electric Supply, Ord.	5	12 %	10 %	10 %	..	8⅝ — 9⅛	8⅝ — 9⅛	9	..	..	5 9 7
81,979	Do. do. 4½ % Cum. Pref. Reduced from 5% since 31st Dec., 1905)	5	4½%	4½%	4½%	..	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..	4 0 0

* Unless otherwise stated, all shares are fully paid. † Quotations on Liverpool Stock Exchange.

Bank rate of Discount 4% per cent., January 6th, 1910.

THE DETERMINATION OF THE TEMPERATURE OF THE FILAMENTS OF INCANDESCENT LAMPS.

By L. CROUCH.

(*Concluded from page 6.*)

THE most recent set of resistance-temperature curves available for filament materials is that published by Jolley (in the *Electrician* for August 13th and 20th, 1909). These curves are based on temperatures determined by the radiation law of equation (3); hence, to use these curves as suggested above would be to "argue in a circle." Nevertheless, starting from these curves, for the sake of example, several interesting results are obtained below.

[Were the dotted curves of fig. 4 not based on radiation measurements of temperature, they could at once be used as above suggested. Having measured the cold resistance of the filament (say at 273 + 15 = 288° C. absolute) the scale to which the ordinate at this value of T (fig. 4) represented the resistance would be used to determine the resistance corresponding to the ordinate at any other value of T or, conversely, would enable the selection of such a value of T that its ordinate represented the "hot" resistance of the filament to the above scale. The hot resistance would be measured by the quotient $\frac{V}{C}$ (V = terminal volts; C = amperes through lamp), hence temperature determination would be reduced to the greatest simplicity.]

Using the radiation equation (3) the accuracy of the temperature determined depends upon the correct choice of the constant to allow for convection effects and the nature of enclosure, &c., as well as on the correct determination of the intrinsic brightness ϕ. The latter condition necessitates the accurate determination of the candle-power of the filament and the effective surface of the latter. The candle-power measurement can be made sufficiently accurately, but the effective area must be rather indeterminate. The expansion of the filament over a temperature range of 2,000-2,500° C. is by no means negligible, and the obstruction offered by one part of the filament to the emanations from another part further increases the danger of errors in the selection of the value of ϕ. The seriousness of relatively small errors in ϕ is shown by the data of Table III and the curves of fig. 5.

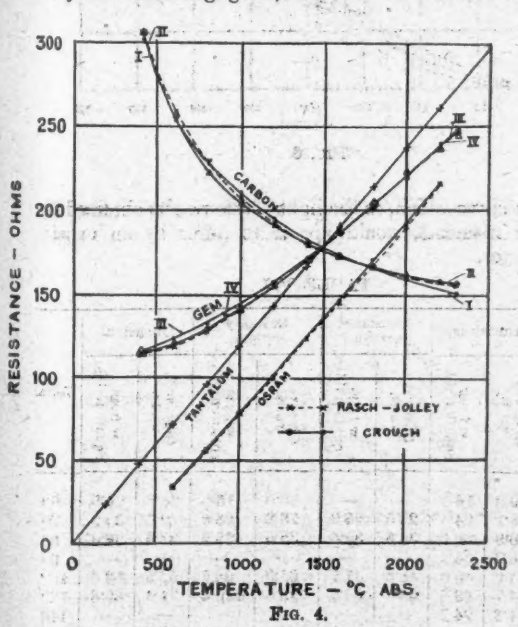


FIG. 4.

Determination of Resistance-Temperature Equations.—Having determined resistance-temperature curves by experiment, the first procedure is to obtain analytical expressions for the same. The process by which this is done is as follows, Jolley's experimental curves being taken as examples.* These curves are dotted in fig. 4, the full curves being plotted from equations obtained as below. From the closeness with which these curves coincide, and from the methods shown below for obtaining them, it will be clear that there is no great difficulty in deducing reasonably accurate analytical expressions, given the fundamental experimental curves.

TABLE III.

ϕ Hefner/sq. mm.	True T °C. Abs.	% error in T for errors in ϕ of per cent.								True T °C. Abs.	ϕ Hefner/sq. mm.
		−20	−15	−10	−5	+5	+10	+15	+20		
1	2,071	1·40	1·06	0·73	0·36	0·36	0·73	1·06	1·40	2,071	1
3	2,262	1·88	1·35	0·84	0·44	0·40	0·80	1·20	1·54	2,262	3
6	2,402	2·00	1·48	0·94	0·46	0·44	0·87	1·29	1·62	2,402	6
10	2,516	2·07	1·51	0·96	0·52	0·48	0·92	1·31	1·73	2,516	10
50	2,962	2·37	1·79	1·18	0·61	0·58	1·05	1·54	1·99	2,962	50
100	3,204	2·60	1·90	1·25	0·65	0·63	1·20	1·76	2·25	3,204	100
150	3,367	2·78	1·96	1·31	0·73	0·66	1·25	1·85	2·40	3,367	150
200	3,494	2·90	2·02	1·41	0·80	0·68	1·30	1·95	2·50	3,494	200
		Negative.				Positive.					

Taking first the tantalum R — T curve, this is remarkably linear in nature, and in addition passes through the zero of temperature, which the "Osram" (tungsten) curve apparently will not do—probably owing to traces of impurity in the filament. Jolley's curve is practically identical with the line represented by—

$$R = 0{\cdot}119\ T. \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The tungsten curve is hardly a straight line. The linear equation most nearly satisfying it is—

$$R = 0{\cdot}1113\ T - 31{\cdot}78, \quad \ldots \quad \ldots \quad (5)$$

but somewhat better approximation is afforded by—

$$R = 0{\cdot}1052\ T + 0{\cdot}00000299\ T^2 - 29{\cdot}2, \quad (6)$$

which represents the full curve shown for tungsten in fig. 4 (see also Table IV).

TABLE IV.

Temperature °C Abs.	Observed R.	R calculated from (5).	R calculated from (6).
600	35	35·0	35·0
800	56	57·2	57·1
1,000	79	79·5	79·0
1,200	100	101·8	101·6
1,400	124	124·2	124·0
1,600	145	146·5	147·2
1,800	168	168·8	170·5
2,000	190	191·2	193·5
2,200	217	213·6	217·0

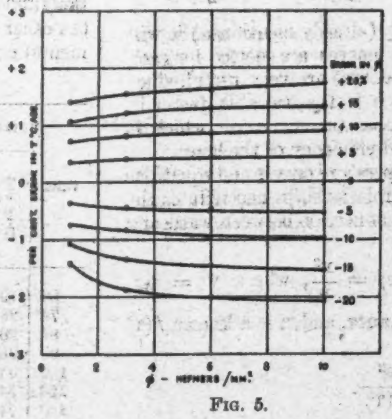


FIG. 5.

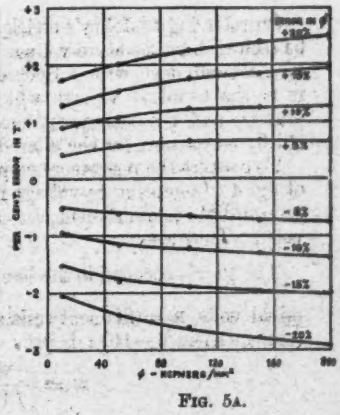


FIG. 5A.

The R-T law for carbon filaments is naturally of the form typical of all materials having a negative temperature-resistance coefficient. The curve between these quantities is of the exponential form, and two equations are given below which will fit the observed curve reasonably well.

* For permission to reproduce these and certain others of Mr. Jolley's curves, the author is indebted to the courtesy of the *Electrician* Publishing Co. and Mr. Jolley.

(*a*) The exponential equation—

$$R = 3{,}197/T^{0.394}, \quad \ldots \quad \ldots \quad (7)$$

gives Curve I, fig. 4, while (*b*) the more unwieldy equation—

$$R = \frac{94{,}000}{T} - \frac{7{\cdot}48 \times 10^6}{T^2} + 118 \quad (8)$$

gives Curve II, fig. 4.

As shown also in Table V, both of these equations have temperature ranges over which one is superior to the other.

TABLE V.

Temperature °C Abs.	Observed ohms.	R calculated from (7).	R calculated from (8).
400	306	301·8	306·0
600	260	256·9	253·8
800	230	229·0	223·8
1,000	206	211·3	204·5
1,200	193	195·8	191·2
1,400	180	184·4	181·2
1,600	174	174·5	174·0
1,800	168	167·8	168·0
2,000	162	160·3	163·1
2,200	—	—	159·0
2,300	156	152·0	157·4

Metallised carbon filaments are intermediate in their characteristics between pure carbon and pure metal filaments: a result which might be anticipated. Within the temperature range dealt with by the curve of fig. 4, the resistance coefficient of "Gem" filaments (metallised carbon) is wholly positive. The equation—

$$R = {\cdot}0261\,T + 16{\cdot}68 \times 10^{-6}\,T^2 + 101{\cdot}9, \quad (9)$$

gives Curve III, fig. 4, which though satisfactory above 1,500° C. abs. is, below this limit, much inferior to the curve represented by—

$$R = 119{\cdot}1 - {\cdot}0377\,T + 7{\cdot}43\,T^2\,10^{-5} - 1{\cdot}468\,T^3\,.\,10^{-8}, \quad (10)$$

a very complex but exceptionally accurate equation (see fig. 4, Curve IV).

The results of the two alternative equations are also shown in Table VI.

TABLE VI.

Temperature °C Abs.	Observed ohms.	R Calculated from (9).	R Calculated from (10).
400	115	115	115
600	119	123·6	120
800	127	133·5	129
1,000	140·5	145	141
1,200	156	157	155
1,400	171	171	171·6
1,600	187·5	186	189
1,800	204	203	205
2,000	220·5	221	224
2,200	239·5	240	239
2,300	249	250	246

On referring to Jolley's article (already mentioned) it will be seen that temperature-voltage curves are plotted for each type of lamp dealt with. Such curves are very useful, since it is the terminal voltage which is the variable factor in practice and the consequent temperature variation which is chiefly responsible for the altered efficiency of the lamp.

To convert the resistance-temperature curves and equations of fig. 4 to temperature-voltage relationships necessitates the intermediate establishment of a connection between watts and volts. Thus:—

The watts expended in the lamp $= \frac{V^2}{R}$, where V = terminal volts, R = filament resistance, and R is a known $f(T)$ (see equations 4—10); hence

$$W = \frac{V^2}{f(T)}.$$

If now the watts can be expressed as a $f(V)$, this may obviously be equated to $\frac{V^2}{f(T)}$, *i.e.*—

$$f(V) = \frac{V^2}{f(T)}, \quad \ldots \quad \ldots \quad (11)$$

whence at once follows the required temperature-voltage law.

The results actually obtained in the present particular example are tabulated (Tables VII and VIII) and graphically represented in figs. 6 and 7.

Determination of Watt-Voltage Equations.—The general relationship between the input watts and the terminal voltage of an incandescent filament lamp is of an exponential nature, and therefore represented by the form of equation—

$$W = K\,V^n. \quad \ldots \quad \ldots \quad (12)$$

The values of K and *n* vary respectively with the size and type of lamp,* but the general form holds for all the lamps here dealt with.

The watt-voltage equations deduced by the author on the assumption of the above general form and by the plotting of log W, log V curves to obtain mean values for *n* and *k* are as follows:—

Tantalum ... $W = 0{\cdot}02714\,V^{1{\cdot}600}$ ... (13)

Metallised carbon $W = 0{\cdot}02721\,V^{1{\cdot}621}$ ... (14)

Ordinary carbon $W = 0{\cdot}0003524\,V^{2{\cdot}235}$ ... (15)

Tungsten ... $W = 0{\cdot}051180\,V^{1{\cdot}508}$ ... (16)

The agreement between these and the experimentally observed results is shown in Table VII and, graphically, in fig. 6. The agreement is excellent, but for one point on the

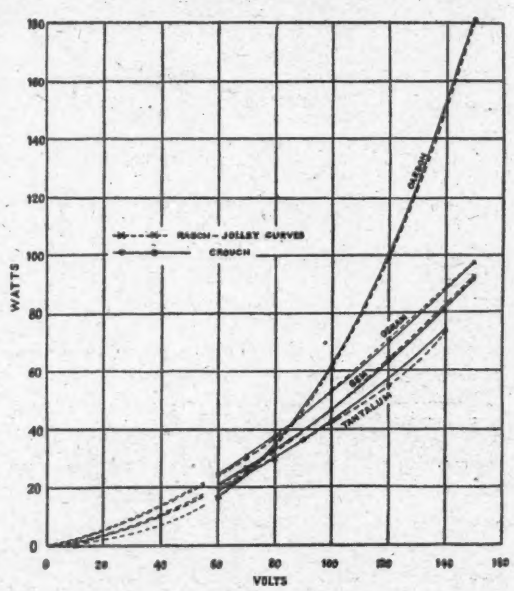


FIG. 6.

tantalum curve which, in the light of the results obtained for the other filaments, would appear to differ by an experimental error.

TABLE VII.

Volts.	Tantalum. Observed watts.	Tantalum. W from equation (13).	Metallised carbon. Observed watts.	Metallised carbon. W from equation (14).	Ordinary carbon. Observed watts.	Ordinary carbon. W from equation (15).	Tungsten. Observed watts.	Tungsten. W from equation (16).	Volts.
60	19·8	19·0	—	—	16·0	16·3	24·8	24·5	60
70	26·1	24·5	26·5	26·9	26·3	25·0	29·6	30·9	70
80	28·8	30·5	33·8	33·4	35·5	35·2	37·5	38·0	80
90	36·3	36·2	—	—	—	—	—	—	90
100	43·0	43·0	46·5	47·7	61·0	62·7	53·5	53·0	100
120	54·7	58·0	64·7	63·9	99·0	100·4	71·4	69·8	120
140	74·2	74·7	—	—	—	—	—	—	140
150	—	—	92·4	91·8	181·4	182·1	97·7	97·7	150

The "observed" watts in Table VII were found throughout by multiplying the C.P. at each voltage chosen by the

* In this connection the reader should refer to ELECTRICAL REVIEW, August 20th, 1909, page 318 *et seq.* Steinmetz there evolves very interesting speculations concerning the watt-voltage laws for tantalum, and gives a set of data which are fully confirmed in their results by the tantalum power equation here obtained.

watts per C.P. under those conditions, the C.P.—V and watts per C.P.—V being the only relevant curves published by Jolley.

Determination of Temperature—Voltage Curves.—The procedure is now as demonstrated generally in equation (11). Thus for "*Osram*" (tungsten) *filaments* :—

$$R = \cdot1052\,T + \cdot00000299\,T^2 - 29\cdot2, \text{ equation (6)}$$

and $W = \cdot05118\,V^{1\cdot308}$, ... equation (16

$$\therefore W\left(=\frac{V^2}{R}\right) = \frac{V^2}{\cdot1052\,T + \cdot00000299\,T^2 - 29\cdot2} = \cdot05118\,V^{1\cdot308},$$

whence

$$V^{0\cdot492} = 0\cdot05118\,(\cdot1052\,T + \cdot00000299\,T^2 - 29\cdot2), \quad (17)$$

and by substituting various values of T in this equation, the corresponding values of V at once follow. These are tabulated together with Jolley's values of V in Table VIII. The

$$\therefore W\left(=\frac{V^2}{R}\right) = \frac{V^2}{0\cdot119\,T} = 0\cdot02714\,V^{1\cdot600},$$

whence $V^{0\cdot4} = 0\cdot00323\,T$, ... (18)

the results of which are also compared with Jolley's values in Table VIII and fig. 7. The present discrepancies are also discussed later.

Passing now to the "metallised" and "ordinary" carbon filaments, the R — T equations available are somewhat less definite (see equations 9 and 10, and 7 and 8, respectively), hence alternative temperature-voltage equations and curves are available. These, however (as shown by Table VIII and fig. 7), are very closely identical in their results over the major part of the voltage range considered, and in no case does the discrepancy anywhere approach in magnitude the difference between the calculated and Jolley's T—V curves. This point, as shown below, is of importance.

TABLE VIII.

Temp. °C. abs.	Tungsten eq. (17)		Tantalum eq. (18)		"Metallised" eq. (19)		Carbon eq. (23)		Temp. °C. abs.	"Metallised" carbon, eq. (21).			Ordinary carbon, eq. (22).		
	Observed volts.	Calculated volts.	Observed volts.	Calculated volts.	Observed volts.	Calculated volts.	Observed volts.	Calculated volts.		Temp. °C. abs.	Observed volts.	Calculated volts.	Volts.	Observed T °C. abs.	Calculated T °C. abs.
400	—	0·5	—	1·9	2·0	20·0	2·5	35·1	400	500	4·0	20·7	5	480	17 2
600	1·5	3·3	2·0	5·2	6·0	22·7	9 0	47·6	600	700	9 0	24 0	10	640	52·3
800	5·5	8·8	5·0	10·7	10·5	27·3	16·0	58 6	800	900	14 0	29·4	20	895	156·4
1,000	12·5	17·1	10 0	18 6	19 0	34 7	25·0	67·6	1,000	1,100	22 0	37 4	30	1,100	297 0
1,200	21·0	28·4	19·5	29·5	26·5	44 5	36·0	75·0	1,200	1,300	32 0	48·0	40	1,280	473 0
1,400	33·3	43·1	31·0	43 7	39·5	57·3	47·5	83·2	1,400	1,500	47·0	63·7	60	1,560	890·0
1,600	48·0	60·3	49·0	60 5	56 0	75 9	63 0	87·1	1,600	1,700	67 0	83 2	80	1,770	1,417 0
1 800	68·5	81·7	70·5	81·3	79 0	93·3	82·5	91·2	1,800	1,900	90·0	109·6	100	1,940	2,039 0
2,000	100	104·7	100·5	106·0	105 0	116·1	105 0	95·5	4,000	2,100	119·0	141·3	120	2,100	2,687 0
2,200	150 a†	—	139 0	134·9	136 0	139·6	130·0	100·0	2,200	2,300	150 0	177·8	150	2,300	3,841·0
2,300	2,250°	144·5	—	—	—	—	147·0	100·9	2,300	—	—	—	—	—	—
2,400	—	—	—	166 0	—	158 5	—	—	2,400	—	—	—	—	—	—

By "observed" data above are meant those deduced from Jolley's curves (see fig. 7).

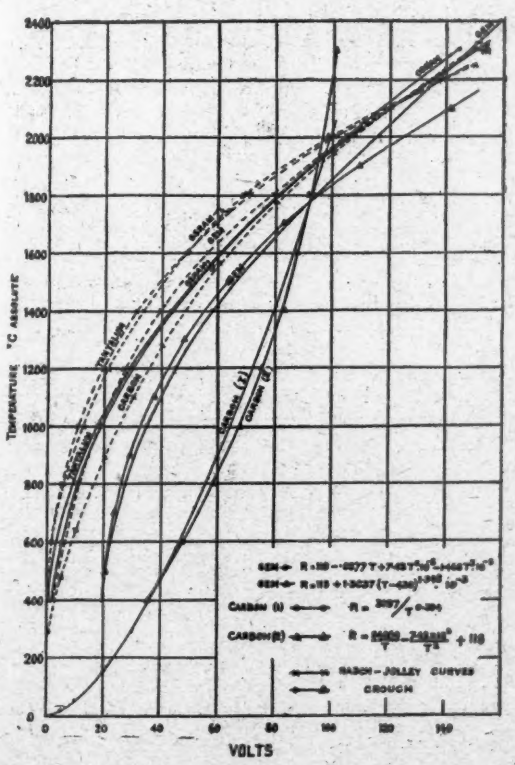


FIG. 7.

two sets of readings are compared graphically in fig. 7. Regarding the discrepancies between the calculated curves and those given by Jolley, more is said later.

Tantalum Filaments.—

$$R = 0\cdot119\,T, \quad \ldots \quad \ldots \text{ equation (4)}$$

and $W = 0\cdot02714\,V^{1\cdot600}$, ... equation (18)

"*Metallised*" *carbon.*—

$$R = 119\cdot1 - \cdot0377\,T + 7\cdot48\,T^2\,10^{-5} - 1\cdot468\,T^3\,10^{-8} = A, \text{ say,}$$

and $$W\left(=\frac{V^2}{R}\right) = \frac{V^2}{A} = \cdot02721\,V^{1\cdot621},$$

whence $$V^{\cdot379} = 3\cdot238 - 1\cdot024\,T\,10^{-3} + 2\cdot02\,T^2\,10^{-6} - 3\cdot99\,T^3\,10^{-10}. \quad \ldots \quad \ldots \quad (19)$$

It will be found that the R of the metallised filaments fig. 4, can yet alternatively be represented by—

$$R = 115 + 1\cdot3037\,(T - 430)^{1\cdot345} \times 10^{-3}. \quad \ldots \quad (20)$$

On this basis—

$$W = \cdot02721\,V^{1\cdot621} = \frac{V^2}{115 + 1\cdot3037\,(T - 430)^{1\cdot345} \times 10^{-3}},$$

i.e., $$V^{\cdot379} = 3\cdot13 + 3\cdot55\,(T - 430)^{1\cdot345} \times 10^{-3}. \quad (21)$$

See also fig. 7, Table VIII, and general comments below.

Carbon Filament.—The results obtained in this case by calculation are radically different from those given by Jolley.

Using equation (7), $R = \frac{3,197}{T^{1\cdot394}}$,

and $$W\left(=\frac{V^2}{R}\right) = \frac{V^2 \times T^{1\cdot394}}{3,197} = \cdot0003524\,V^{2\cdot635},$$

i.e., $$T^{1\cdot394} = 1\cdot124\,V^{1\cdot635},$$

whence $$T = 1\cdot347\,V^{1\cdot589}, \quad \ldots \quad (22)$$

which connects T and V as required.

Now this equation, based on two preliminary equations, which closely agree with the experimental data from which they were deduced, shows T to ∝ a higher power of V than unity, whereas Jolley's T — V curve bending over ⌒ shows T to vary with a power of V less than 1.

The second T — V equation deduced below supports equation (22) (see fig. 7 and Table VIII) though the equation (23) is of very different outward appearance.

Again, by general reasoning it would appear that the temperature-voltage curve for any material with a negative

temperature coefficient of resistance should be $>$ and *not* $<$. Thus:—

On increasing the voltage across a filament of such material, the current flowing would be doubled were the resistance constant and the pressure doubled. The heating watts would therefore be quadrupled, and, assuming constant emissivity, the a T between the filament and the surrounding medium would be quadrupled. As a result of the increased temperature, however, the filament resistance in this case will fall. Suppose, for the sake of argument, that it is halved—the current will rise to four times its original value, and the heating watts will be increased $(4)^2 \cdot \frac{1}{2} = 8$ times. It is clear, therefore, that the filament temperature will rise extraordinarily rapidly with V; in fact, the power of V involved is < 1 for materials with a positive temperature-resistance coefficient, and > 1 for those with a negative coefficient. The exact relationship in the present case is alternatively expressed by equations (22) and (23), which, by their method of deduction, by their close agreement and by their general accord with the well-known sensitivity of carbon filaments to voltage fluctuations, appear to the author to represent the true temperature — voltage relationship for carbon filaments.

The alternative equation (No. 23) referred to above is thus obtained:—

$$R = \frac{94{,}000}{T} - \frac{7{\cdot}48 \times 10^6}{T^2} + 118 = B, \text{ say,} \quad (8)$$

then $W = {\cdot}0003524\ V^{2{\cdot}635}$ ... ... equation (15)

$$= \frac{V^2}{B},$$

whence

$$0{\cdot}0003524\ V^{0{\cdot}635} = \frac{T^2}{94{,}000\,T - 7{\cdot}48 \times 10^6 + 118\,T^2}. \quad (23)$$

As regards the T — V equations for tantalum, tungsten and metallised carbon, these materials have positive temperature-resistance coefficients, and hence give curves of shape similar to the Jolley curves (fig. 7). The calculated curves are throughout based on the experimentally obtained R — T and watts-voltage curves, and, with the exception of the carbon curves, the full curves (calculated) of fig. 7 lie between the Rasch and Stefan curves shown by Jolley (*loc. cit.*), and probably represent the true filament temperature more nearly than either of these two curves alone.

The case of the ordinary carbon filament is discussed above; "Gem" or metallised filaments partaking of the nature of carbon, but being chiefly metallic in their R — T laws, give a temperature-voltage curve which, while being of the same form as those of the pure metals, is lowered somewhat by the carbon influence.

Conclusion.—Admittedly some of the conclusions drawn above are somewhat controversial in nature but, apart from such disputable points, the author believes the present notes to be a useful and practical aid to the study of the temperature phenomena of incandescent filament lamps. The analysis of experimental curves is well exemplified, and the general methods and arguments here employed are perfectly applicable to all similar investigations.

Claim Under the Workmen's Compensation Act.—Before Judge Shand, at the Liverpool County Court on Friday, January 7th, an application under the Workmen's Compensation Act was made by Mrs. Sarah Jane Peters, and her three daughters and son, of Litherland, in respect of the death of James Peters, who had been a motor driver in the employ of respondents, the Liverpool Overhead Railway Co., Ltd. The case for applicant was that on Sunday, October 10th, 1909, Peters was driving an electric train upon which the slipper connecting the motor with the live rail became out of order four times. Peters, in pursuance of his duty, strapped it up with a piece of rope furnished to drivers for that purpose. Later in the day Peters dropped dead in the motor box of another train to which he had been transferred, and the post-mortem examination, made by order of the Coroner, revealed that deceased's heart was weak. It was now sought to establish that the death, which was due to heart failure, had been caused, accelerated, or contributed to by the undue exertion of getting into an awkward position to fix the slipper. Without calling on counsel for respondents, his Honour said he was quite satisfied that the fastening up of the slipper had nothing to do with the man's death, and he found in favour of respondents.

INCANDESCENT FILAMENT LAMP RATINGS: "WATTS" v. "CANDLE-POWER."

By S. M. POWELL.

There are obviously two characteristics whereby the performance of an electric lamp can be specified: (*a*) the watts input required (= terminal voltage × amperes flowing through the filament); (*b*) the candle-power emitted by the lamp. Of late there has been considerable controversy regarding which of these specifications should be generally employed. Hitherto the candle-power (whether English or hefner) has been generally adopted, and in the following notes the writer believes he satisfactorily demonstrates the advisability of adhering to this procedure (apart from the desirability of continuity of nomenclature).

In the first place, it should be remembered that the wattage and candle-power of a lamp are of necessity connected by the usual method of expressing the efficiency of a luminous source. Thus:—

$$\left.\begin{matrix}\text{Total}\\ \text{watts}\end{matrix}\right\} = \frac{\text{M.S.C.P.}}{\text{Efficiency in watts per M.S.C.P.}} = \frac{\text{M.H.C.P.}}{\text{Efficiency in watts per M.H.C.P.}}. \quad (1)$$

In Favour of a "Watt" Rating.—Undoubtedly, from the manufacturer's point of view, the wattage of a lamp is the simplest and most convenient method of specification. True, he must first ascertain the C.P. of units which will best compromise manufacturing possibilities and the wishes of his customers. From a knowledge of the average efficiency of the type of lamp concerned, these candle-powers can be at once converted to the equivalent wattage, and thenceforth it is by far the simplest course for the manufacturer to adhere to wattage alone in designing, manufacturing, and classifying the lamps.

In the design of the filament the voltage at which it has to be run is known. Thence from the wattage follows the current which must be passed, and so the resistance of the filament, the ratio between the length and diameter of which is then determined by the manufacturing limitations, emissivity of filament, and the desire for a low or high candle-power unit, as the case may be. (Note that the candle-power requirements have again to be consulted at this point.)

In the manufacture of the filament the correct length and the degree of "flashing" or of burning off (in the case of filaments subjected to such processes) are readily controlled by a voltmeter and ammeter across and in series with the filament respectively.

In testing the finished lamp, it is vastly simpler and no doubt more accurate to determine its wattage rather than its candle-power.

Confusion at present exists between the English standard candle-power, the hefner, the carcel and the bougie, whereas a wattage rating would be international in its significance. The present confusion between the standards of candle-power is not, however, likely to persist long, and has been largely removed during the past few months by international conferences and tests, &c.

Beyond the above arguments the author is unaware of any other claims which can be advanced in favour of wattage classification. Turning, however, to the other side of the discussion:—

In favour of a "Candle-Power" Rating.—The candle-power of a lamp is a measure of the useful effect obtained from it. It is for its light-giving properties—for its candle-power, in fact—that a lamp is bought, and it would appear only reasonable to sell it under a description of its capabilities in this respect.

To determine the capabilities of a lamp by its wattage rather than by its candle-power is exactly analogous to classifying a gun by the weight of its charge rather than by the kinetic energy of its projectile, to classifying a boiler by its coal consumption instead of by its steaming capacity, and to stating the steam consumption of an engine instead of its horse-power. In fact, such a classification amounts to rating by input rather than by output. Both are of interest to the user or purchaser of the lamp or engine, but it is the *output* which he requires, and for which he purchases a suit-

able apparatus. In most cases this *output* must be obtained at any cost; the purchaser will always inquire as to the input necessary, and will appreciate any economy therein; but to suggest that he should purchase his lamp or engine on an *input* classification is ridiculous.

It has been shown that an input classification in the case of lamps is very convenient to manufacturers, just as the cylinder feed ultimately becomes the starting point in the design of a steam engine. There is no objection to the retention of the input rating till the lamp or engine leaves the manufacturer's works, so long as this rating is then translated to C.P. or H.P. respectively for the consumer's benefit.

The consumer is greatly interested in both ratings, and the logical course is to stamp both the candle-power and the wattage on every lamp, just as every engine is specified by its horse-power *and* steam consumption. If, however, only one rating is to be allowed, that must be the candle-power once the lamp has left the manufacturers.

The average consumer does not know the meaning of the term "watts," nor does he wish or need to. He requires a certain light, and while always desiring it as cheaply and as efficiently as possible, that light he insists upon having. By arranging his lamps as scientifically as possible, and by taking canvasser's or salesman's more or less accurate advice, he obtains his specified illumination (and possibly more if he employs the new high-efficiency lamps) as cheaply as possible, but throughout it is the obtaining of the requisite light which primarily concerns him. If he cannot obtain that amount of light for the monetary outlay he is prepared to make, he uses gas or some other illuminant. The question of the wattage of his lamps does not concern him.

No doubt the consumer could be educated up to the comprehension of a "watt" rating, but it would always be necessary to specify the efficiency of the lamp ere he could obtain any idea of the amount of light obtainable from it. On a candle-power basis the suitability of the lamp as an illuminating factor is at once expressed, but the wattage must be known in order to estimate the running cost. It is usual, however, for the salesman to inquire the price which his customer pays per B.T.U., and then to show him a lamp of the desired candle-power, saying meanwhile that it will cost so much per hour to run. There is absolutely no need to confuse the purchaser with wattage problems. Moreover, however familiar the customer may become with "watts," he must always, consciously or unconsciously, translate wattage to candle-power. The lamp is to produce light, and by its capability of so doing it must always be fundamentally classified. Colour and diffusion difficulties exist (as below), but it is the *light* that is wanted and the *light* which must be specified.

The manufacturer can retain his convenient wattage rating, but must finally reduce it to a candle-power basis, even if only approximately from the average efficiency of a number of lamps—such an approximation would serve all ordinary purposes.

It may be urged that the candle-power of an incandescent lamp is a very indefinite quantity, its effective value in service depending on whether the M.S C.P., the M.H.-S. C.P., or merely the M.H.C.P. is utilised, on the screening, frosting and reflectors used, and on the general arrangements of the lamps and the nature of their surroundings—whereas the wattage of the lamps is constant. This is so, but the consumer is most interested in the light he will obtain, and to inform him that the wattage of his lamp is constant at such and such a value however he may employ it is of secondary importance to him. He wishes to know the maximum candle-power with which he can start off from the lamp; of the general effect producible therefrom, and the proportion which he may expect to lose by shades, diffusion, &c., the average householder has a surprisingly clear conception.

At present a consumer goes to buy a 16 or 32-C.P. lamp, asks its price and kind; that kind he knows is costly to run, good or excellent as the case may be, and he completes his purchase with a quite sufficient knowledge of the whole transaction. On the other hand, if all lamps were classified by wattage, he would have to remember that a 100-watt carbon lamp would give about 25 C.P., a 100-watt tantalum lamp about 65 C.P., while a 100-watt tungsten lamp would yield over 80 C.P. He would reckon that he required so many candle-power, and would then have to translate it to the wattage of the kind of lamp he desired to employ. This operation, whether consciously or unconsciously effected, is inevitable. The estimation that such and such a wattage must be expended in such and such a kind of lamp is merely a clumsy alternative expression of the candle-power needed (see equation (1)).

In conclusion, the results of the above considerations may be summarised thus:—A wattage rating is most convenient for the manufacturer, but even that necessitates at least two references, in the course of design and manufacture, to the candle-power required. A candle-power rating is most convenient, and, indeed, essential for the consumer. An ideal arrangement is to state both the candle-power and the watts. If the watts alone be stated, the consumer must know the efficiency of the lamp before he can obtain any idea of its light-giving qualities. In the words of Dr. Bell, speaking in 1908 before the Institution of Electrical Engineers:—"Lamps in America are rated in watts, but the *candle-power is distinctly part of the rating.*"

So it must always remain.

PARLIAMENTARY.

Contemplated Tramway Construction.

THE following estimates have been prepared by the engineers for tramway works for which Parliamentary sanction is being sought in the coming session:—

Rhondda Urban District Council (R. Hammond, engineer).—Construction of tramway, £29,450; equipment, £5,000; purchase of land, &c., £35,318...	£69,768
Nottingham Corporation (A. Brown, City engineer).—Construction of tramways, £23,769; electrical equipment, £2,575; rolling stock, £6,750; land and buildings and street improvements, £28,813; construction of street improvements, £12,537 ...	74,444
Leeds Corporation (W. T. Lancashire, City engineer).—Provision of trolley omnibuses, £5,000; providing electrical equipment and construction of other works for working the omnibuses, £9,000	14,000
Bradford Corporation (W. H. S. Dawson, engineer).—Tramway construction, £55,506; works other than tramway, £64,530	120,036
Dunfermline and District Tramways (Hawtayne and Zeden, engineers).—Tramways, £118,100; street works, £5,400	123,500
Wemyss Tramway Extensions (S. Sellon, engineer).—Constructing 13 miles 3 furlongs 5·40 chains of tramway, £60,287; street widenings, £1,250; land for generating station, £1,100	62,637
Handsworth Urban District Council (Kennedy and Jenkin, and Cheshire, Gibson & Co., engineers) ...	75,707
Southampton Corporation (J. A. Crowther, borough engineer).—Construction of tramways, £10,440; provision of posts, &c., £1,540; lands and buildings and street works, £24 747; construction of embankment and road, £55,330	92,057
London County Council (M. Fitzmaurice, engineer).—Tramways £955,000, and street widenings £640,000	1,595,000

Standing Orders.—Memorials have been deposited in the Private Bill Office by the Borough Councils of Hampstead and Marylebone and the Willesden Urban District Council, against the London County Council's Tramways and Improvements Bill, alleging non-compliance with Standing Orders.

International Congress on Radiology and Electricity.—The Board of Education has received through the Foreign Office a notification that an International Congress on Radiology and Electricity will be held at Brussels in 1910 (September 13th-15th). The work of the Congress will be organised in three sections; the first dealing with Terminology and Radiometry, the second with Physical Science, and the third with Biological Sciences, with a sub-section for Medical Radiology. The following English scientists are members of the general committee:—Sir W. Crookes, Sir W. Huggins, Sir O. Lodge, Sir W. Ramsay, Lord Rayleigh, and Profs. Rutherford and Schuster. For further details application should be made to Monsieur l'Ingr. Dr. J. Daniel, secrétaire général, 1 rue de la Prévôté, Brussels.

THE PHYSICAL SOCIETY'S EXHIBITION.

(*Concluded from page* 10.)

Snell & Tinsley.

This firm had a very interesting exhibit, including an improved siphon recorder designed by Mr. Tinsley for both long and short cables, Dr. Drysdale's alternating-current potentiometer, sine flux phase shifter for use with the A.C. potentiometer, phase-shifting transformer, and a variety of condensers, resistance boxes and bridges, &c.

We illustrate herewith the Tinsley Universal potentiometer, as supplied to the Board of Trade Standardising Laboratory; it is designed for use with a single accumulator, and has a range from $\frac{1}{1000000}$ volt to 18·1 volts. The whole of the adjustments can be made on the instrument itself, two rheostats being provided for this purpose; the fine adjustment rheostat is fitted with a micrometer screw, with which an adjustment to $\frac{1}{10000}$ volt can easily be obtained. The main balancing coils are of manganin, in 17 sections, in series with a platinum-silver slide wire divided into 110 equal parts. The slider is drawn by silk cords, to avoid thermal effects. Two keys are provided, for the standard cell and the test pressure respectively. When several circuits are necessary, a selective switch can be used, containing the necessary fuses, and connected to the potential terminals on the instrument. The connections are shown in fig. 1; it will be noticed that a special two-way plug switch is fitted in the top left-hand corner. When the plug is in the right-hand position, the readings range from one microvolt to 0·181 volt; when in the left-hand position, 10 microvolts to 1·81 volts; and when 20 volts are applied at the battery terminals, the range is 100 microvolts to 18·1 volts. The shortness of the bridge wire is a special feature of the instrument.

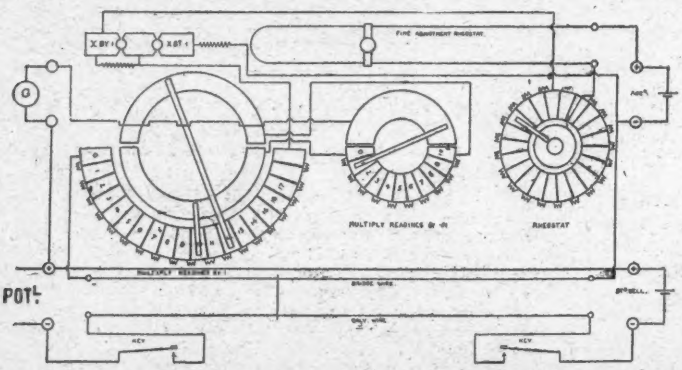


FIG. 1.—CONNECTIONS OF POTENTIOMETER.

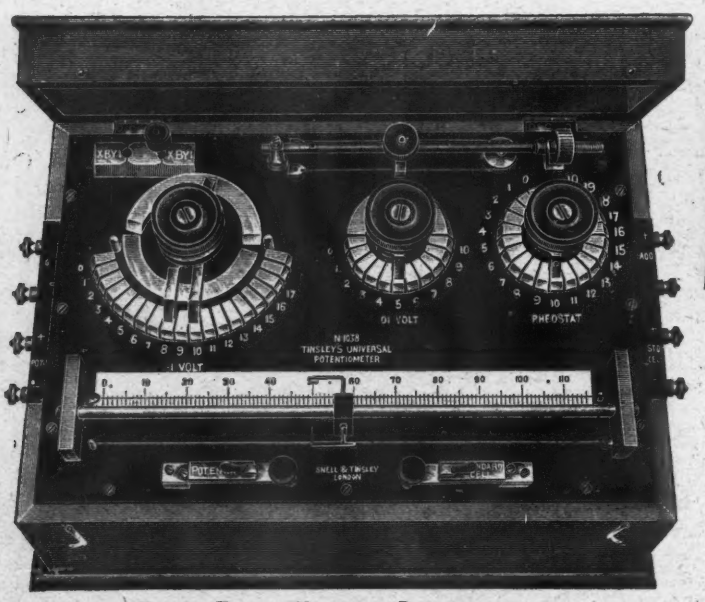


FIG. 2.—TINSLEY UNIVERSAL POTENTIOMETER.

A. C. Cossor, Ltd.

The Lodge vacuum tube rectifiers and the Gehrcke oscilloscope were shown, together with Mr. W. R. Cooper's patent speed indicator, in which a rotating tube containing mercury is employed, and a new rotary high-vacuum mercury pump, made of steel, and working in conjunction with a low-vacuum rotary oil pump.

Isenthal & Co.

In addition to Mosciciki condensers, new patterns of resistances and frequency indicators, Messrs. Isenthal exhibited a new pattern "precision" Wheatstone bridge, with a novel type of terminal clamp, capable of holding equally well fine wire and stout rods.

Elliott Brothers.

The Wimperis Accelerometer (described in the ELECTRICAL REVIEW of December 3rd, 1909), was shown, as well as the latest form of the Harrison photometer, micrometer gauges, portable and switchboard measuring apparatus, and testing sets.

India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.

In addition to Silvertown portable testing sets, a four-dial Wheatstone bridge and a Rymer-Jones standard condenser (built up of separate radiating elements of sheet mica with a metallic coating on both sides, as described in the ELECTRICAL REVIEW of June 30th, 1905), the India-Rubber Co. showed Mr. Raymond-Barker's two-tone transmitter and the Gott fault-searcher coil for use with it. The transmitter is an improvement on the Cardew vibrating transmitter, in that the electrical impulses utilised are not alternating, but are endowed with a positive or negative bias, so that equal time value reversal signals such as are used with the siphon recorder are produced, capable of reception by telephone, mirror galvanometer, or recorder. The two tones are more easily read on the telephone in the presence of cross-talk and extraneous noises than the Morse signals. The system is applicable not only to cable work, but also to military signalling, and to the working of very faulty landlines. When the transmitter is used at a shore station in conjunction with a Gott fault-finder on a cable ship held against a cable, the shore station is able to communicate inductively with the ship, and the ship, by using a two-tone transmitter connected to the fault-finder, can speak to the shore, after a joint has been made and covered, and up to the time when the sheathing is spliced. In actual practice such communication has been effected over 60 miles of cable. When used conductively, the system has given very clear acoustic signals through 100 miles of cable. The latest form of transmitter, with a single electro-magnet, is shown in fig. 3.

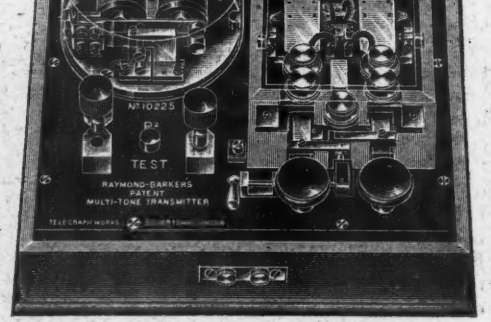


FIG. 3.—RAYMOND-BARKER SINGLE-ELECTRO-MAGNET TRANSMITTER.

Leslie Miller.

Mr. Miller exhibited a mercury-jet current interrupter for large induction coils, smaller current interrupters, and the Lewis-Jones

current pulsator. The last-named device is used for gradually varying the current passing through a patient from zero to a maximum about 15 times a minute, by means of a simple liquid resistance worked by clockwork. One of the devices exhibited was intended for use on a D.C. supply, giving an intermittent or alternating current, capable of working a cautery transformer with an output of 10 amperes.

Muirhead & Co., Ltd.

Besides minor apparatus for use in submarine telegraphy, Messrs. Muirhead exhibited a Kelvin recorder and cable relay combined; between the armature of the vibrator and the glass siphon of the recorder was stretched a fine gold wire, which made contact on two silver pins, the vibration of the wire preventing "stiction" between it and the contacts. The instrument could be used for both purposes simultaneously. Muirhead's stretched-wire relay for use in the local circuit of cable relays was also shown.

British Radio-Telegraph and Telephone Co., Ltd.

This company exhibited a receiving station for wireless telegraphy; detector and tuner were combined in a single piece of apparatus, and switches were provided for making all the necessary changes of connections.

C. F. Casella & Co.

Most of this exhibit was non-electrical, but in the Hennah and Bissel patent automatic course recorder and indicator, an electromagnetic system was employed to record the deviation of a ship from the course laid down, and to ring an alarm bell on a certain deviation being attained.

Miscellaneous.

The system of telegraphing photographs, worked out for the *Daily Mirror* by Mr. T. T. Baker, was shown in operation. MESSRS. A. GALLENKAMP & CO., LTD., exhibited a pyrometer set for students, Darling's patent compensator for cold junctions of thermo-electric temperature measuring apparatus, and various physical apparatus. MESSRS. J. J. GRIFFIN & SONS, LTD., showed Tucker's patent primary battery, electroscopes for radioactivity experiments and physical apparatus. MR. J. J. HICKS had a variety of apparatus on view, including electrical recorders of the direction and velocity of the wind. MESSRS. MARCONI'S WIRELESS TELEGRAPH CO., LTD., showed an improved form of valve receiver for wireless telegraphy.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

N.C.S. Leakage Indicator for A.C. Circuits.

The method here described for indicating the occurrence of a fault on A.C. mains has been designed to meet the requirements of the Home Office rules for the use of electricity in mines. In order to comply with these regulations, it is necessary that the leakage indicator should not only act as a safeguard in the event of a bad fault occurring, but should also give a permanent indication as to the condition of the mains. For A.C. circuits, the

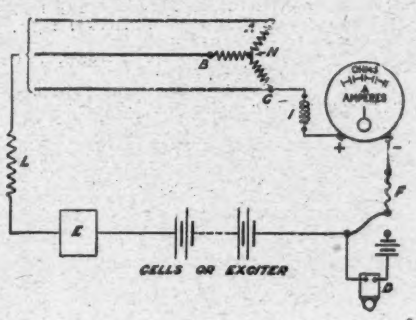


FIG. 1.

best method of measuring the insulation resistance is to superimpose a small direct current on the A.C. system; it is this principle that is used in the N.C.S. leakage indicator. While this method can be applied to single, two or three-phase circuits, it will here be described with reference only to three-phase work, as it is for such systems that in the majority of cases the leakage indicator is required.

Fig. 1 shows the arrangement for insulated systems; the source of direct current may either be a primary battery or the exciter of the A.C. generator. It will be seen that in series with the indicating instrument is inserted a large inductive resistance L. This, though it has a comparatively low ohmic resistance, offers a very high impedance to the alternating current, preventing the flow of anything more than two or three milliamperes, even if subjected to the full line voltage.

The indicating instrument consists of a D.M. moving-coil ammeter, which is unaffected by alternating currents. The instrument is scaled to read direct in ohms and amperes. The top reading of the ampere scale is equal to $\frac{1}{1000}$th of the maximum current of the system, this being the maximum allowable leakage as fixed by the Home Office rules. The actual leakage current will never be greater than that indicated by the ammeter, but under certain circumstances may be less. If the insulation resistance of the

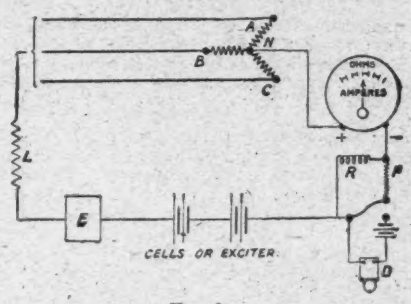


FIG. 2.

system falls below the allowable limit, the fuse F attached to the spring contact blows, thereby closing a local bell circuit D, which at once gives the alarm.

Fig. 2 shows the connections for systems in which the neutral is earthed. Here the ammeter is connected in the earth circuit; this, however, in no way impairs the earthing of the neutral, as the resistance of the instrument and battery is only a few ohms. In the event of the fuse F blowing, a resistance R is thrown into circuit; this prevents the neutral from being entirely disconnected from

FIG. 3.

earth, and at the same time makes it impossible for any very large current to flow through the instrument, which might otherwise be damaged.

Fig. 3 shows the earth panel fitted up with the necessary apparatus. On the front is mounted the instrument fuse, and, if required, a change-over switch; the latter is only supplied for earthed systems, and when thrown over from one side to the other simply short-circuits the instrument, thus providing a more direct earthing of the neutral. At the back of the panel are arranged the battery (usually contained in a wooden case), the choker, or resistance, together with the bell, and the necessary two or three Leclanché cells.

The apparatus is manufactured by MESSRS. NALDER BROS. AND THOMPSON, LTD., of 34, Queen Street, E.C.

"Metaliters" at the Pantomime.—At the invitation of the directors, the employés of the Bryant Trading Syndicate, Ltd. ("British Metalite" lamp), went to the pantomime "Babes in the Wood," at the Marlborough Theatre, Holloway, one night last week. The whole of the pit stalls were reserved for their accommodation.

FOREIGN AND COLONIAL TARIFFS ON ELECTRICAL GOODS.

JAMAICA.—The free schedule embraces practically everything employed in the generation, storage, distribution and use of electricity, including telephonic installations. Telegraphs are not mentioned, but wireless telegraph installations for communication with places outside the colony cannot be erected without a licence from the Governor. Electrical and similar apparatus not on the free list is subject to a duty of 16⅔ per cent. *ad valorem* on the market value, inclusive of packing, &c., at the place whence imported.

JERSEY.—The Harbours Committee is authorised to levy a duty of 2s. 6d. for import duties on each ton of 40 cb. ft., or on each ton of 2,080 lb. gross weight on goods imported into Jersey, the minimum duty on a package being fixed at 1d.

LAGOS (SOUTHERN NIGERIA).—Importers must present an invoice in duplicate with a full description of the goods, giving the quantity and value of each kind of goods imported, and showing the marks and numbers on the packages so as to indicate truly the quantity and value of the articles included in each package. The packages must be legibly marked and numbered on the outside. A statement of the country of origin of the goods must be made on the declaration. Invoices for goods, of which the value exceeds £10, must be attested by the owner or exporter in the country whence the goods were exported before any person authorised to administer oaths, but this requirement will not be enforced in practice if a guarantee is given to supply an attested invoice if necessary. No person may establish or use any apparatus or installation for the purpose of electrical communication by wireless telegraphy in Southern Nigeria without a licence from the Governor.

The following goods are admitted free of duty:—

All goods imported with the sanction of the Governor for the service of any Public Department of the Colony; building and roofing materials; scientific instruments; machinery and implements for mining, agriculture or industry; telegraph materials.

A duty of 10 per cent. *ad valorem* is levied on goods not mentioned above.

The value on which *ad valorem* duty is calculated is the fair market value of the goods when sold for home consumption in the principal markets of the country whence and at the time when the same were exported directly to Lagos.

LIBERIA.—The following goods are admitted free of duty:—

Faulkner's telephone, &c., material; machinery and mining tools; goods for improvements in Monrovia City; scientific instruments.

Other electrical and similar goods pay a duty of 12½ per cent. *ad valorem*.

An export duty of 6 cents per lb. is levied on rubber and gutta-percha, and an export duty of 12½ per cent. *ad valorem* on other goods, except mining produce.

MALTA.—No import duties are levied on electrical and similar goods imported into Malta.

MAURITIUS.—The following duties are payable:—

Brass ware	15 per cent. ad val.
	Rupees.
Copper (red) in sheets, bars, nails, pipes, &c.	12 per 100 kg.
„ (yellow) „ „ „ „ „	6 „
„ wares	12 per cent. ad val.
India-rubber caoutchouc	25 per 100 kg.
Iron wire, galvanized	1·50 „
„ „ not galvanised	1 „
Steel, unwrought	2·75 „
Machinery for the manufacture of sugar, rum, aloe fibre, and other produce of the colony	1·32 per 1,000 kg.
Ditto if the crane is used for landing ...	2·32 „
Articles not specified in the tariff	12 per cent. ad val.

The value on which *ad valorem* duty is calculated is the current value of the goods at the port whence they are imported.

15 rupees = £1. Kg. = 2·204 lb.

Aluminium Price Movement.—It is stated that the price of aluminium on the European continent had fallen to about £3 per cwt. by the middle of December, and this seems to have induced consumers to exercise greater activity in covering their requirements. As a consequence of the increased demand, the price of the metal has recovered to about £3 7s. 6d. per cwt. As to the endeavours made to form a syndicate, it appears that nothing has lately become public on the question, although it is assumed that the idea has not been abandoned by the works concerned, notwithstanding that it has hitherto been impossible to reconcile the diverging interests.

NEW PATENTS APPLIED FOR, 1909.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford, to whom all inquiries should be addressed.

30,260. "Mechanical device for counting telephone calls." J. D. Taylock. December 28th.

30,262. "Means for controlling electric motors." W. Witter. December 28th. (Complete.)

30,291. "Improvements in and relating to multiple switches and the like." E. N. Bray and Bray, Markham & Reiss, Ltd. December 28th.

30,305. "Improvements in electrical alarms." J. S. Jones. (Date applied for under Sec. 91 of the Act, December 28th, 1908, being date of application in United States.) December 28th. (Complete.)

30,321. "Improvements relating to the control of alternating electric current motors." W. B. Sayers. December 28th.

30,322. "Improvements in or relating to alternating electric current generators." W. B. Sayers. December 28th.

30,331. "Improvements in brushholders employed in electrical apparatus." W. A. Stevens, Ltd., and W. A. Stevens and A. T. Lambert. December 28th. (Complete.)

30,333. "Improvements in electric generating machines." E. M. Fitz. December 28th.

30,352. "Improvements connected with telephone instruments." P. B. Clarke. December 29th.

30,458. "Improvements in or relating to telephone exchange systems." T. G. Martin. December 30th. (Complete.)

30,463. "Apparatus for electrolytically removing the grease from objects to be galvanised." H. W. T. Schulte. December 30th. (Complete.)

30,479. "Improvements in incandescent electric lamp fittings." A. A. Barron. December 30th.

30,482. "Improvements relating to dynamo-electric machines." M. Walker. December 30th.

30,548. "Improvements relating to the insulation of condensers for telephone circuits." C. Cordes. December 31st.

30,550. "Improvements in electric wave meters and the like appliances." J. E. Taylor. December 31st.

30,556. "Improvements in or relating to alternating electric current systems." H. A. Mavor, H. M. Hobart and Mavor & Coulson, Ltd. December 31st.

30,561. "Improvements in electric switches." A. H. Curtis and Adams Manufacturing Co., Ltd. December 31st.

30,566. "Improvements in electric controllers, starting switches, and the like." A. H. Curtis and Adams Manufacturing Co., Ltd. December 31st.

30,579. "Improvements in selective electric signalling." W. J. Thorrowgood. December 31st. (Complete.)

30,599. "Improvements relating to the control or regulation of electric ignition apparatus for internal-combustion engines." W. P. Thompson. (E. Eisemann & Co. G.m.b.H., Germany.) December 31st. (Complete.)

30,602. "Improvements in the manufacture of separators for use in electrical batteries and electrolytic apparatus." P. Marino. December 31st.

PUBLISHED SPECIFICATIONS.

Copies of any of the Specifications in the following list may be obtained of Messrs. W. P. Thompson & Co., 285, High Holborn, W.C., and at Liverpool and Bradford; price, post free, 9d. (in stamps).

1908.

Manufacture of Metallic Frictional Blocks, such as Brake Blocks, Electrical Collector Stoppers and the like. W. Taylor. 20,718. October 1st. (Post-dated September 15th, 1909.)

Electrical Relay Devices. B. Thomas and E. Thomas. 20,772. October 2nd.

Telephone Message Pad Holder. E. C. Digby. 26,004. December 2nd.

Apparatus for Starting and Governing Electrically-Driven Ring Spinning Frames. Akt.-Ges. Brown, Boveri et Cie. 26,228. December 4th. (Date applied for under International Convention, January 18th, 1908.)

Electric Lampholders. W. Fennell and W. P. Perry. 26,752. December 10th. (Cognate application 3,556 of 1909.)

Cluster Lampholders for Electric Incandescent Lights. Julius Sax & Co. and H. C. Wheat. 26,929. December 11th.

Contrivances for Detecting and Recording the Passage of Electric Impulses. A. Orling. 28,367. December 29th.

1909.

Telephonic Receiving and Transmitting Apparatus. P. M. Oliver. 12,857. June 1st.

Raising and Lowering of Arc Lamps and the like. A. Wunderlich and G. A. Hughes. 14,972. June 26th. (Application for Patent of Addition to No. 25,898/07.)

Switch for Plugs for Telephone Exchanges. Siemens Bros. & Co. (Siemens and Halske Akt.-Ges.) 18,836. August 9th. (Application for Patent of Addition to No. 9,592/09.)

Apparatus for Electric Telegraphs. Siemens Bros. & Co. and G. S. Grimston. 19,603. August 25th.

Automatic Telephone Exchanges for Calling One of Several Subscribers on the same Line. Siemens & Halske Akt.-Ges. 21,978. September 27th. (Date applied for under International Convention, November 19th, 1908.)

Electric Transformer Distribution Systems. Allgemeine Elektricitäts Ges. 92. January 2nd. (Date applied for under International Convention, January 2nd, 1908.)

Telephone Circuits. A. H. Nicholson. 604. January 9th.

Attachement of Telegraph and Similar Line Wires to Insulators. W. E. Bendfield. 1,009. January 15th.

Electrical Heating Apparatus. A. F. Berry. 1,414. January 20th.

Electrical Heating Apparatus. A. F. Berry. 1,415. January 20th.

Steel Armouring of Electric Cables. E. A. Claremont and J. Stratton. 6,809. March 22nd.

Machines for Covering Wire or Electric Conductors with an Insulating Material. H. L. Owen. 7,582. March 29th.

Arrangement of Connections for Electric Tension Measurement Apparatus of Dynamometric Construction. Horn. 10,003. April 27th. (Date applied for under International Convention, April 27th, 1908.)

Splicing Ear for Electricity Conductors. J. C. Russell and A. F. Lord. 11,209. May 12th. (Date applied for under International Convention October 31st 1908.)